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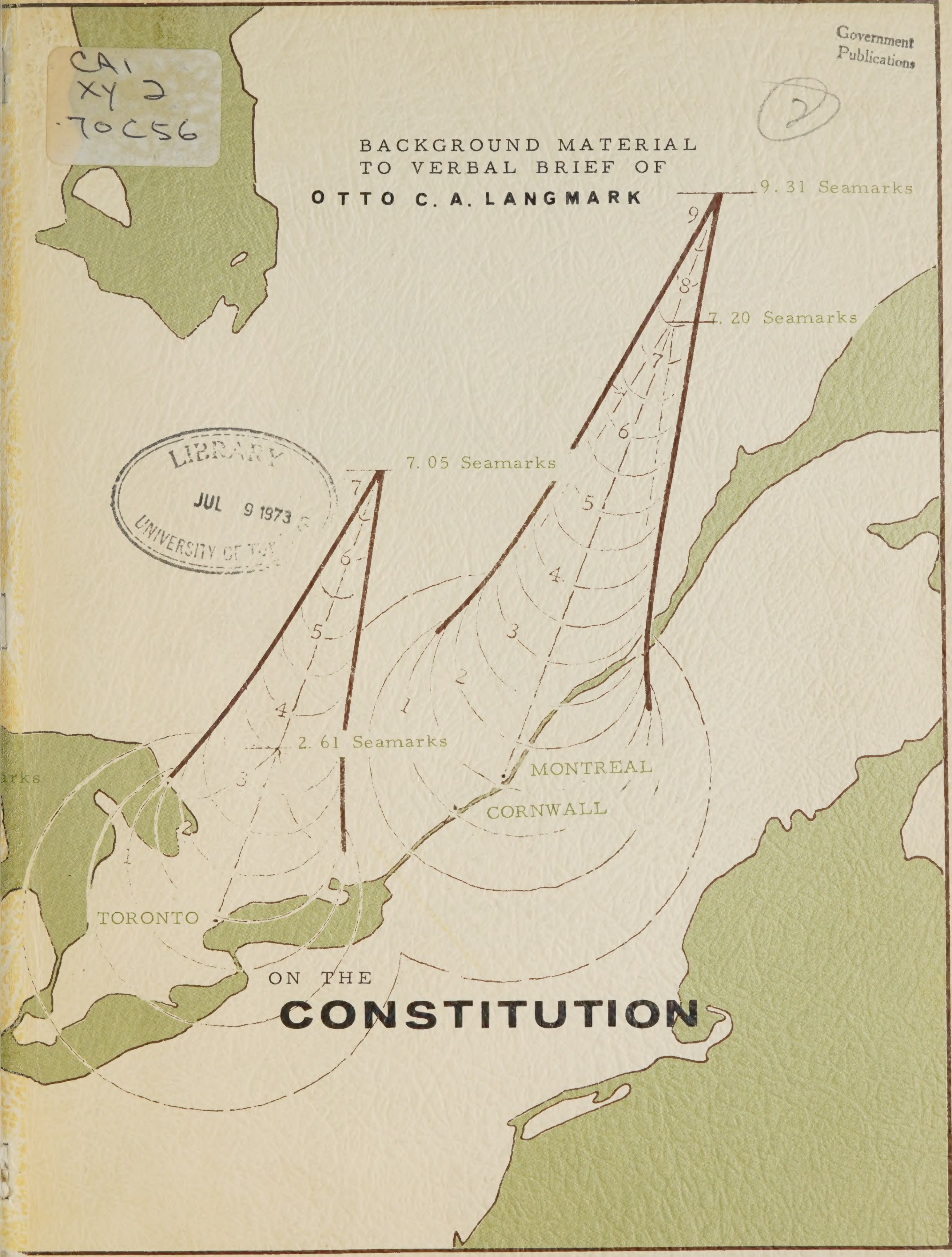
BACKGROUND MATERIAL TO VERBAL BRIEF OF

OTTO C. A. LANGMARK

ON THE CONSTITUTION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Canada Parliament

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PUBLIC HEARINGS

of the Special Joint Committee of the Senate
and of the House of Commons on the

CONSTITUTION OF CANADA

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BACKGROUND MATERIAL
TO VERBAL BRIEF OF
OTTO C. A. LANGMARK

HAMILTON HEARING
TUESDAY, December 8, 1970 — 7:30 p.m.
(Holiday Inn)

OTTO C. A. LANGMARK
Dip. T.P. (Sydney), Dipl. Ing. Arch. (Berlin),
F.R.A.S.

360 Torrance Street, Apt. 1408,
BURLINGTON, Ontario,

16 th of January, 1971.

The Honourable Members of the Special Joint Committee
of the Senate and the House of Commons
on the Constitution of Canada.

Dear Sirs:

It gives me great pleasure to forward to you upon the following pages a copy each of the documents used on Tuesday night the 8th of December, 1970 in Hamilton, Ontario in my verbal brief about the Constitution. You might recall that my brief consisted of two rather different parts. The first part was a fairly straight forward description of an administratively difficult procedure. By contrast, the second part was technically more involved, concerning itself with the causes underlying the process of growing urbanization and trying to anticipate the legislative measures necessary.

As no doubt the members of the Committee are aware, in land use planning there is a sphere of overlap of jurisdictions just in those areas where most of the people will live in the next century. The description of how in practice an inter-governmental organization has been set up, perhaps not necessarily in conflict with the Constitution, and how the administrative procedures are being worked in practice, was the subject of part one of the brief.

In part two of the brief we tried to catch a glimpse of one of the possibilities of what our society (in Ontario) might look like sometime between the years 2001 and 2031, and attempted to see what we can learn from that picture. This examination has led us to the question of how to define the city of the 21st century and the problem of what might form a suitable urban district to be represented in the Legislative Assembly. There are two concepts which appear capable of helping us in these investigations, we called them the concepts of relative and integral accessibility, and a certain minimum of coverage upon this subject was included in the brief as it required only a little additional effort, and helped to complete the picture.

The presentation of the documents in this brief retains the above-mentioned sequence.

Yours very truly,

O. C. A. LANGMARK

PART ONE

Background material to the description of a procedure which, although probably not unconstitutional, was almost certainly not envisaged in full extent at the time of confederation in 1867 or when the B. N. A. Act was enacted, but having been forced upon us under the pressure of practical necessity, is followed more and more often in urbanized areas today.

IN THE FIRST PART of the brief the writer illustrated his arguments on maps of two Ontario cities, Hamilton and Cornwall, and a reproduction of the plans used is included in Part One of this report. The first map shows the proposed boundaries of a Metropolitan Hamilton, Ontario, the city where the author is at present in charge of Long Range Planning. The next map shows in dark the extent of all the urban land uses of said Metropolitan Hamilton in a long range projection, and it was pointed out at the hearing that a meaningful proposal of the land use designations within the dark areas of the plan can hardly be made without some knowledge of the proposals in the adjacent areas marked blue, which proposals as they would usually concern matters of navigation would be under the B. N. A. Act subject to Federal jurisdiction. Thus as was pointed out by the writer at the hearing, with the increase of urbanization some of the most important issues of our lives have to be decided by a procedure which involves all three levels of government in the task of land use planning.

The third map of Part One is the Land Use Plan of the 1968 Official Plan, bearing the author's name, of the City of Cornwall, Ontario; and as was pointed out at the hearing the necessity of a planning procedure involving all three levels of government re-occurs here, only with greater intensity. The areas marked orange denote Federal transportation corridors, St. Lawrence Seaway, railways, Provincial transportation corridor of Highway 401, the other colours indicate all the land uses assumed to be subject to the jurisdiction of the local Council as was pointed out in the presentation.

Theoretically at least, within the framework of the B. N. A. Act the Federal authorities should be making all decisions concerning the St. Lawrence Seaway, perhaps even without regard to the Provincial Government and/or the local municipality concerned. The municipality in turn was expected by the B. N. A. Act of making all the local decisions such as taking care of the conservation of the shores of the newly created lakes west of Cornwall, locating the positions of oil tank storages and of industries along the Seaway and of solving the approach ramps to the international bridges without any information from the Federal Government.

While this might have been possible or perhaps even necessary in the largely rural society of 1867 and perhaps still possible in the infant industrial society of the 1930's, today practically the problems subject to Federal jurisdiction cannot be satisfactorily solved without regard to matters of local land use planning, and matters of local (delegated Provincial) jurisdiction cannot be solved without knowledge of matters under Federal jurisdiction, and experience is teaching us that a three-tier planning process not envisaged anywhere in the B. N. A. Act is becoming one of the cornerstones of the practical legislative procedures concerning matters of land uses of the society of the 21st century.

The boundaries of the City of Cornwall underlying the 1968 Official Plan of that City, were established by Ontario Municipal Board Order P.F.M.-1742 Part III, issued Friday, 3rd August, 1956 under the chairmanship of L. R. Cummings, Q. C. The areas constituting the City of Cornwall as delimited by that Order contain a complete urban organism including parts of the navigable waters of the St. Lawrence River. Thus in formulating an Official Plan based upon these boundaries it would be possible to take into consideration all facets of life.

In comparison with these advanced views in the delineation of a city of the 20 th century, it appears to the writer as a flaw, that a closure of the boundaries (perhaps as indicated upon the two maps reproduced here in black and white) was not included within the recommendations for the boundaries of a proposed Metropolitan Hamilton in the recommendations of the otherwise excellent Steele Report of 1969.

In the pre-industrial society of the 1800's the power of man was limited. In the 20 th century, with the employment of machinery of millions of horsepower an increasing percentage of the decisions of the Federal jurisdiction requires a consideration of matters of local land use (and space use) unless we want to run the risk of unnecessarily causing damages by said machinery of millions of horsepower to the local urban organism. Is it thus just the age-old problem raising its head in a new disguise, of a city trying to gain control of the navigable waters upon its own shores? It seems more accurately described as the task of all three levels of government which have jurisdiction within a particular urbanized part of the geographical space, constituting the Dominion of Canada. It appears to the writer rather as a requirement for a procedure in which the technical experts of all three levels of government would sit together in the drafting of certain pieces of legislation, and make as certain as they possibly can that firstly, the technological devices created within the framework of this legislation are not damaging to society and secondly, that a conflict of laws does not arise.

Now such process of planning the uses of areas of the space we live in in some manner or another, directly involving all three tiers of government, local municipality, Provincial government and Federal government was nowhere envisaged in the 19 th century agricultural confederation nor in the 1930's, when the Constitution was enacted. Today in practice such procedure is being followed more and more often, having been forced upon us under the pressure of necessity.

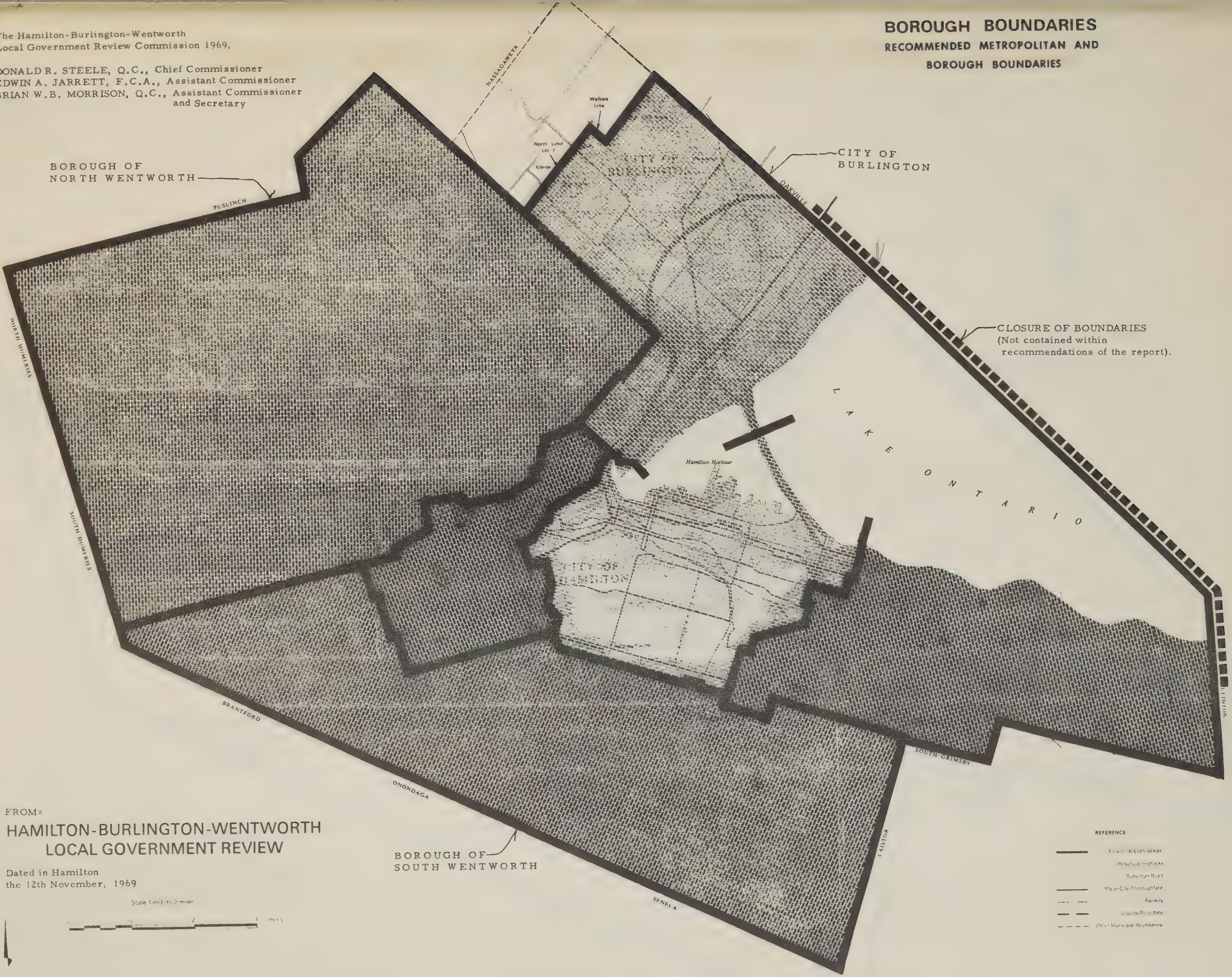
Thus with increased urbanization, a new manner of work is practically developing before our eyes, a procedure which although probably not unconstitutional was most certainly not envisaged at the time of confederation in 1867, nor at the time of drafting and passing of the British North America Act, a procedure in which decisions are made involving the authority of all three levels of government.

The Hamilton-Burlington-Wentworth
Local Government Review Commission 1969,

DONALD R. STEELE, Q.C., Chief Commissioner
EDWIN A. JARRETT, F.C.A., Assistant Commissioner
BRIAN W.B. MORRISON, Q.C., Assistant Commissioner
and Secretary

BOROUGH BOUNDARIES

RECOMMENDED METROPOLITAN AND BOROUGH BOUNDARIES


BOROUGH OF
NORTH WENTWORTH
CITY OF
BURLINGTON
CLOSURE OF BOUNDARIES
(Not contained within
recommendations of the report).
LAKE ONTARIO
Hamilton Harbour
CITY OF
HAMILTON
BOROUGH OF
SOUTH WENTWORTH
NASSAGAWEYA
Walkers Line
North Limit Lot 7
Kilbride
OAKVILLE
CLINTON
SOUTH GRIMSBY
CAISTOR
SENECA
ONONDAGA
BRANTFORD
SOUTH DUMFRIES
NORTH DUMFRIES
PUSLINCH
REFERENCE
Provincial Expressway
Provincial Highway
Suburban Road
Major City Thoroughfare
Railway
County Boundaries
Other Municipal Boundaries
Scale 1 inch to 2 miles
0
2
4
miles

FROM=

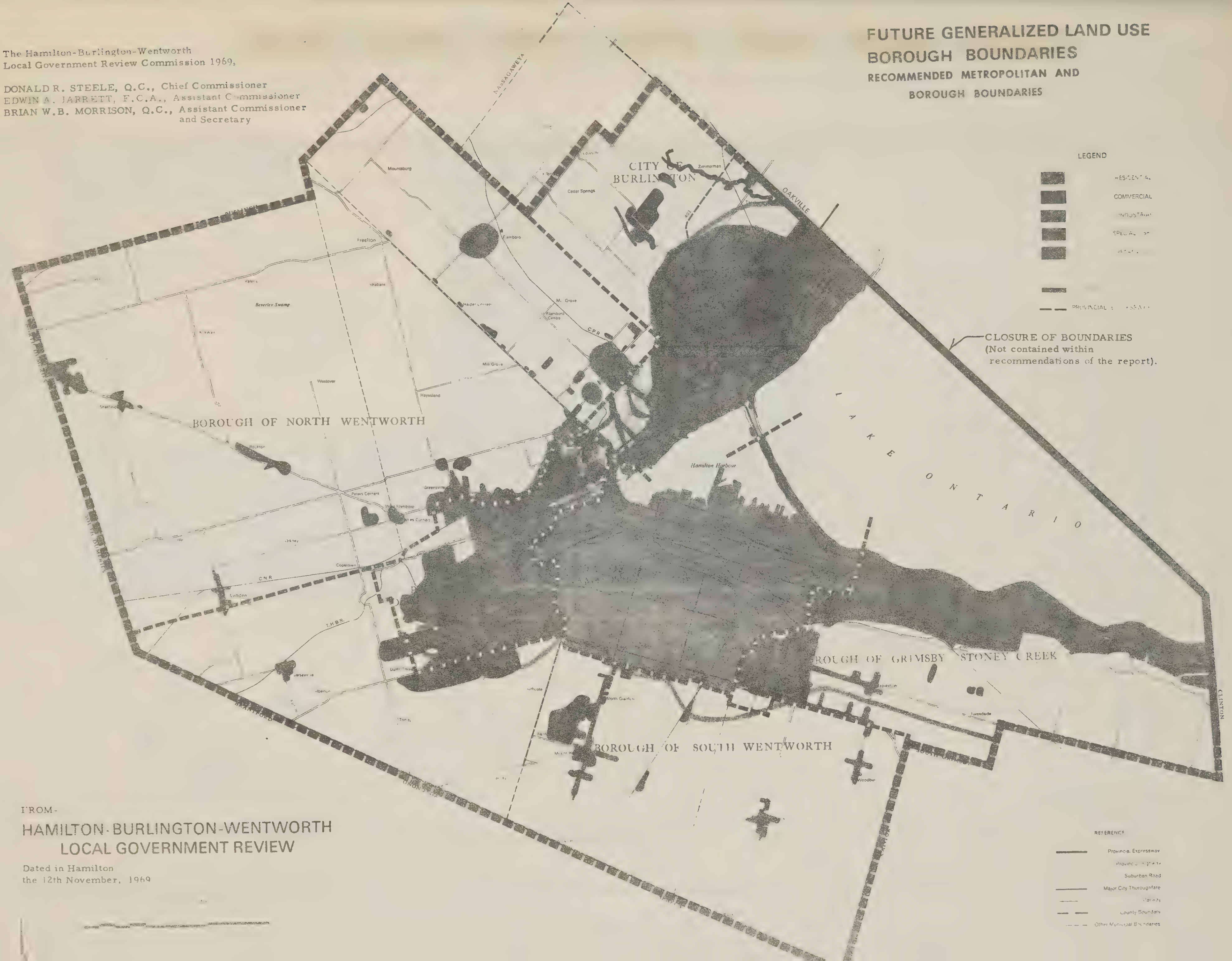
HAMILTON-BURLINGTON-WENTWORTH LOCAL GOVERNMENT REVIEW

Dated in Hamilton
the 12th November, 1969

The Hamilton-Burlington-Wentworth
Local Government Review Commission 1969,

DONALD R. STEELE, Q.C., Chief Commissioner
EDWIN A. JARRETT, F.C.A., Assistant Commissioner
BRIAN W.B. MORRISON, Q.C., Assistant Commissioner
and Secretary

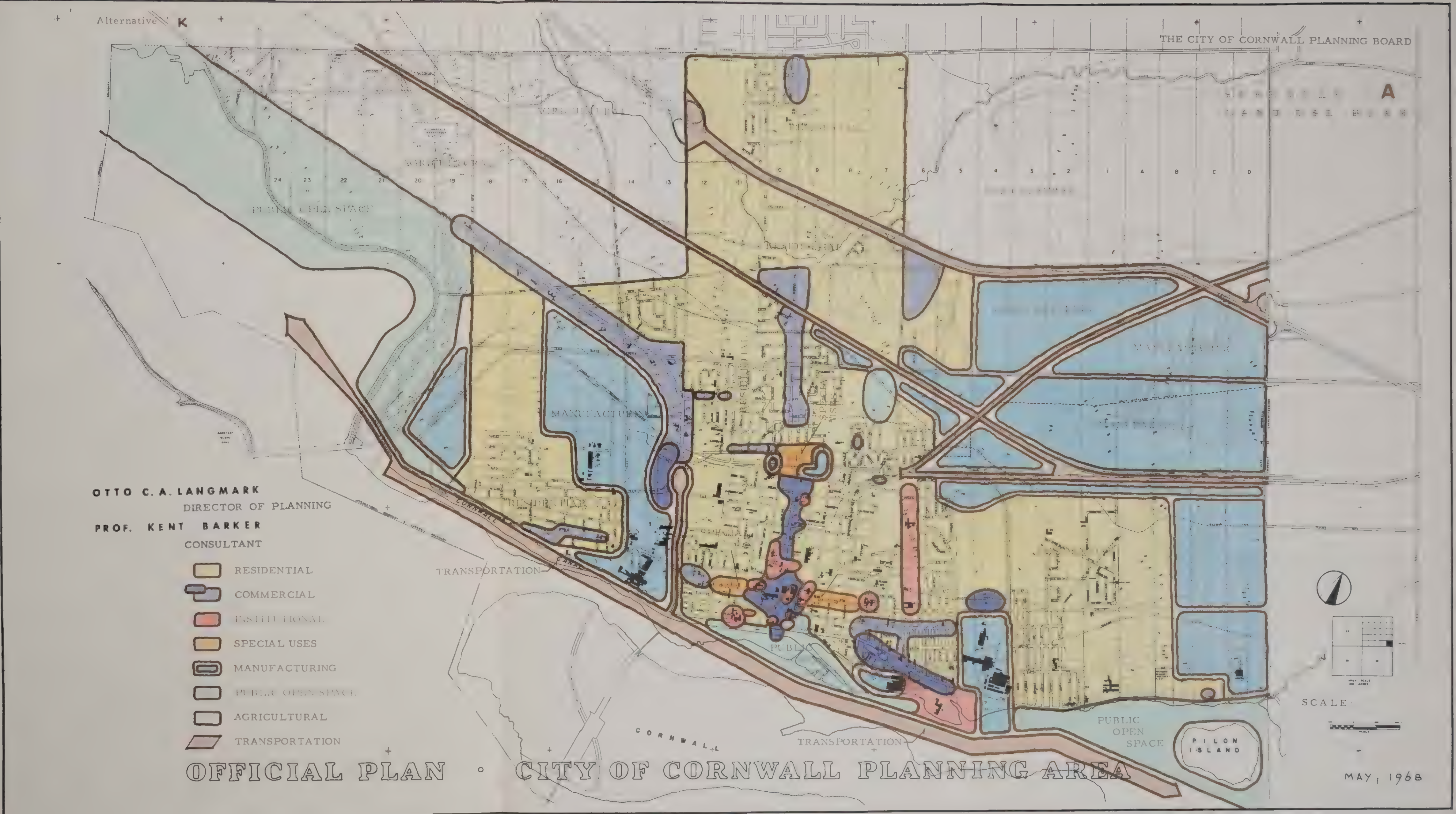
FUTURE GENERALIZED LAND USE
BOROUGH BOUNDARIES
RECOMMENDED METROPOLITAN AND BOROUGH BOUNDARIES


LEGEND
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
SPECIAL
PROVINCIAL
CLOSURE OF BOUNDARIES
(Not contained within
recommendations of the report).
CITY OF BURLINGTON
LAKE ONTARIO
Hamilton Harbour
BOROUGH OF NORTH WENTWORTH
BOROUGH OF SOUTH WENTWORTH
BOROUGH OF GRIMSBY STONEY CREEK
OAKVILLE
NASSAGAWEYA
CLINTON
Zimmerman
403
Cedar Springs
Mountsburg
Freelton
Flamboro
Mt. Grove
Flamboro Centre
CPR
Strabane
Valens
Beverley Swamp
Westover
Mill Grove
Hayesland
Sheffield
Rockton
Peters Corners
Greensville
Copetown
CNR
Lynden
T.H.B.R.
Jerseyville
North Glanbrook
Woodburn
Tweedside
REFERENCE
Provincial Expressway
Provincial Highway
Suburban Road
Major City Thoroughfare
Railway
County Boundary
Other Municipal Boundaries

FROM-

HAMILTON-BURLINGTON-WENTWORTH
LOCAL GOVERNMENT REVIEW

Dated in Hamilton
the 12th November, 1969


Alternative K
THE CITY OF CORNWALL PLANNING BOARD
SCHEDULE A
LAND USE PLAN
AGRICULTURAL
PUBLIC OPEN SPACE
RESIDENTIAL
MANUFACTURING
SPECIAL
PUBLIC
TRANSPORTATION
CORNWALL
CANAL
PUBLIC OPEN SPACE
PILON ISLAND
24
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OTTO C. A. LANGMARK
DIRECTOR OF PLANNING
PROF. KENT BARKER
CONSULTANT
RESIDENTIAL
COMMERCIAL
INSTITUTIONAL
SPECIAL USES
MANUFACTURING
PUBLIC OPEN SPACE
AGRICULTURAL
TRANSPORTATION
SCALE
MAY, 1968

OFFICIAL PLAN · CITY OF CORNWALL PLANNING AREA

PART TWO

Background material to a proposal which might be of help in the future in defining a "City".

PART TWO, in contrast with Part One, was technically a fairly complex subject. The background material of this Part Two presented at the hearing and reproduced here in turn consists of three different subsections. The first subsection illuminates and describes the situation with which we might be faced at the turn of the century, particularly if a three day working week should be established. The second subsection proposes a solution of one of the difficulties which we might encounter, should the expectations described in the first subsection come to pass. In defining the city of the 21st century we might have to fall back upon the characteristics of the distribution of jobs at the core, and this in turn is closely associated with the concepts of integral and of relative accessibility. The third and last subsection contains two fold-out maps from the "Draft Official Plan 1970" of the City of Hamilton, illustrating the shape of the core of that city in terms of the distribution of jobs today.

As I have mentioned at the hearing, I for one could envisage a constitution in which ten provinces would be represented on equal footing with nine cities: Quebec City, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Calgary, Edmonton and Vancouver.

Marked upon the page called "Distribution Model", there is that unique centre which forms the core of the City of Hamilton. In that model of a year between 2001 and 2031, there is that unique location, in which all the gainfully employed residents from the wide area congregate each week for three working days, and these congregating breadwinners ought to elect the "Representative of the City of Hamilton".

Soon over 85% of our (non-factory) jobs will be located in one or the other of the dozen or so of pinnacles of high integral accessibility, such as the centre of Hamilton upon the page "Distribution Model". Thus we might be having the daytime population of about a dozen centres contain during daytime hours over 85% of our breadwinners and income tax payers, and of the representatives of the financial and actual power of this nation, each pinnacle being defined by its employment core.

Not all the meaningful part of the activity of a man in his lifetime takes place at his place of residence. Those knowledgeable in techniques of radio reception and of the manner of tuning in to the voice of a particular station, will be familiar with the idea of "crystallizing out" a particular voice from among a jumble of wavelengths. Unless we find a means of "crystallizing out" from among the choir of voices of the 21st century of the "Distribution Model" the voices of those who congregate with unfailing regularity three or more times a week at the core of the City of Hamilton, be it for work, or for cultural activities, or for leisure, the study of the meaning of the voices is bound to be more difficult, the interpretation of the local problems more defective and the response of the organization less sensitive.

The large urban organisms of the year 2000 of Canada should have constitutional status otherwise the Federal institutions become insensitive to local necessities.

If the development depicted in the "Distribution Model" would come about, the local residents of the City of Hamilton would NOT represent the meaning of that city in the life of Ontario, and I certainly do NOT envisage, and I personally do NOT think it would be of much use, for the electorate of the cities of the 21st century such as depicted upon the "Distribution Model" to consist of local residents. Rather, I would suggest that the taxpayers who pay their Federal income tax from income earned in the City of Hamilton would form the electorate of that "city's" representative in the Federal Government.

Possibly the natural constitutional form of Canada of A. D. 2031 would be a confederation of a dozen cities, perhaps only the power of dealing with urban problems should be vested in Federal Government. In either case the crucial question arises: how would we define, for electoral purposes, the "City of Hamilton" in the Distribution Model? To attempt to circumscribe the area of influence of the core of Hamilton in the "Distribution Model" for election purposes somehow in terms of residential population is quite useless. Indeed in the time of the "Distribution Model" the concepts of residence and of domicile, inherited from the pre 19th century agricultural society of yesteryear, will probably have become meaningless.

Perhaps the only possibility, or perhaps just the best one, would be a definition based upon the daytime population and thus closely connected with the characteristics of the employment core, such as the employment core of Hamilton depicted upon the last three pages of illustrations contained in this brief. The question of whether or whether not North Bay, Ontario would be in the group, one among the ten or eleven cities previously mentioned, would depend on whether or whether not there is such peak of employment in North Bay, as the peak portrayed upon the last two fold-out illustrations of this brief.

This is the reason why the writer thinks, as mentioned at the end of the background to this brief, that questions of distribution of professional, clerical and other C. B. D. and non-factory jobs, and the closely associated question of integral accessibilities deserve our closest study.

With this having been said, the remainder of what follows in this report is literally what it is called, namely background material against which to judge. The first page points out that it is not unreasonable to expect a three day working week within the lifetime of the new Constitution. The next page presents the "Distribution Model" for a three day working week. The page following introduces the concept of integral accessibility and the last two fold-out pages illustrate the present employment core of the City of Hamilton.

Indeed, the areas wherefrom the eye can behold sea and land simultaneously in the same view are amongst God's most beautiful creations on this Earth.

... and we do therefore suggest that this tendency of man, or at least of the modern seafaring nations towards the coast, is good. But we do not deceive ourselves about the nature of the powers that will finally decide the issue. There are economic and psychological powers very closely related to the concept of integral and relative accessibility operating on the life and distribution of mankind.

BACKGROUND MATERIAL

EMPLOYMENT TRENDS

The upper diagram of the page "Employment Trends" presents graphically the average number of hours worked per annum in 1969, and the year in which the production of said year 1969 could be reached, assuming the rise in the level of our production rate per hour worked, remains between 2.5 and 4.0% per annum. The black bars represent the 2.5% rate, the horizontally striped bars 4.0%.

The top of the bars indicate, that if we were content in Canada, with not consuming more than in 1969, all our needs could be produced within 1040 working hours per year in A.D. 1993 assuming the lower limit experienced in the rate of increase of productivity (2.5%), or even in the year 1984, if the productivity per hour grows at the rate of 4.0% per annum. Thus under the above-mentioned assumptions sometime between the years of 1981 and 1996 (1977 and 1986) a three day working week would come within reach.

Now we all know of course, that the rise of productivity in the decades past always gave rise to demands in consumption. Indeed an increase in consumption for capital formation and an increase of consumption for transportation purposes might be unavoidable, in order to maintain an increase in productivity. The predictions underlying the Economic Report of the U. S. A. President and dated January 1966 are therefore less dramatic. The thirty-three hour working week would be reached there only sometime in 1997, (The lower half of the page "Employment Trends").

As we wish and hope that our newly revised constitution should be good for more than merely the next thirty years, we must expect that within the lifetime of our said new constitution we shall reach the three day working week. If and when this happens, we might expect some fairly dramatic changes in our patterns of living, working and recreation.

See also: Tables 28-1 and 28-2 of Henry H. Willard (City College of New York): Economic Performance (Holt Reinhart and Winston, 1962).

> In the period of 1865 to 1965 A.D.,
>
> Hours worked declined from 67 to 40 per week = - 40%
> Years worked declined from 55 to 45 per life = - 18%
> Real income per workers lifetime increased fivefold,
> Real income per man hour increased eightfold.
>
> Thus on the foregoing basis a 30 hour working week (75% of 40 hours) would be reached 56 years from 1965, that is in A.D. 2021.

See also page 502 of Papers, 80 th Annual Meeting (1967) of American Economic Assoc.

> In 1865 man worked an average of 188,000 hours during his lifetime, this total declined by 53% during the following 100 years, so that in 1965 a man worked 88,000 hours during his lifetime.
>
> In a projection of this trend, in 2065 a man would work 41,500 hours per lifetime, say at 26 hours per week at 46 weeks per year for 35 years.

DISTRIBUTION MODEL

The future will be determined not only by what is probable and possible, but by what we as a society determine to be necessary, allowable and ultimately desirable. The attractive powers of a place for residential development is only partly economic in its nature. Human will, preferences, prejudices or desires are an important element. "Opinion can do much, and in fact, she is that great Lady that rules the world". So some say that the greater part of the "call" of a place is psychological. There is a certain desire perceptible in human kind, to live its life in close proximity to water in the landscape.

Assuming we have by then solved the water pollution problems of our Great Lakes, there is one turn development might certainly take. Throughout history, since the times, when man learned to navigate the seas, there is a movement of populations perceptible, from the interior of continents towards the shores of the oceans. (It has been estimated that if every British family were to want a bit of seafront, the entire seacoast of England, Scotland and Wales would provide an average of 33 feet of seafront per family).

The desire to live near the water might perhaps be one of the wishes of the Ontario population of the 21st century which can be fulfilled, and it is not suggested that this trend is bad. The areas of the seacoast the world over are esthetically so much superior that it is basically desirable to have as many people as possible living in contact with this beautiful environment. Think of the surroundings of Sydney in Australia, with the radiant Warringah Peninsula, or think of Puget Sound in B. C. or of the dramatic verticals reflected in the Bay of Rio de Janeiro. Indeed the areas wherefrom the eye can behold sea and land simultaneously in the same view are among God's most beautiful creations on this earth, and we do therefore suggest that this tendency of man or at least of the modern seafaring nations toward the coast is good. But we also do not deceive ourselves about the nature of the powers that will finally decide the issue. There are economic and psychological powers very closely related to the concept of integral and relative accessibility operating on the life and distribution of mankind.

Today in the 1970's the population has to live within daily access to a job. With a three day working week people can spend the two nights between the first and third days of work in an apartment near their place of work and would be free to spend the remaining five nights in their residences near the water, The housing areas would then be distributed according to the "Distribution Model" which was based on a normal relative accessibility range (average) of a hundred miles relative to their place of work as shown. The concept of normal relative accessibility was used to obtain the distribution here.

Be it just mentioned here how we get in per cents the relative accessibility of any two points say from "n" to point "k". To the mathematical reader we can say that the relative accessibility is in principle a frequency function, with the mode in the point of departure or arrival. To ask what is accessible from point "k" has no meaning. All we can answer is, that today in the 20th century any point of our Globe (and many a place beyond) is accessible from "k". It is an entirely different matter if we specify a range, say by asking what is accessible from "k" within an hour. This question can be answered. Thus we have to deal with two further subjects here and now with distances shrinking along communications and with the concept of a range.

The concept of shrinking distances is not a new concept. It has been accepted for some time that since the introduction of fast mechanized transport distances have shrunk along communications. The concept of a range is also not very new. It has been known for a long time that phenomena often cover a certain range. The distance we can travel for recreation on a Saturday afternoon, the ranges of various aircraft types, the area covered by the firearms of a battleship or the distances determined by the time and fares people are able and willing to afford for daily travel to work today are some examples.

The relative accessibility of two points "k" and "n" is then given by:

$$(\text{N.R.A.})_{n,k} = \exp -\left[\left(\frac{a+c}{r_0}\right)^2 + \left(\frac{b}{Lr_0}\right)^2 \right]$$

in which "L" represents the shrinkage factor upon distances along a line of transportation, "r_0" is the range of one hundred miles in the present case "b" is the distance travelled along a line of communication and "a" and "c" are the distances from the line of transportation to points "n" and "k" respectively. All the integral accessibilities of this report are based upon the 100 mile range (except the two cones upon the page "Accessibility and CBD Employment").

EMPLOYMENT DISTRIBUTIONS

This picture of possible things to come in A.D. 2001 to 2031 raised several questions in the discussion period from a number of Honourable Members as to whether the population is concentrating in conurbations, or whether it is dispersing. As the writer sees it, what is concentrating at present are the jobs. This problem is dealt with upon the last three pages of the illustrative material of this brief.

It is the opinion of the writer that places of employment are the most volatile objects of human society, so long as they are not located in the most accessible places. It is often not clearly understood that jobs not established in locations of highest integral accessibility (or as closely as possible to them) have the tendency to move at a slightest violation of their unstable equilibrium into the above-mentioned locations. In fact, such employment moves so easily, that since the last eighty years or so, since man created by mechanized transport places of extremely high (integral) accessibility, and left some places

without mechanized transport as little accessible as they were before, there came into being, and continues, an almost uninterrupted flow of jobs into places of highest integral accessibility.

For Robinson Crusoe, this flow of employment might be of academic interest only. He owns his island, and can not leave his inaccessibility. For the rest of our inter-connected humanity, in which more than 90% depend for survival on a job, the situation is in about 120 places of our Globe today as follows:

The huge integral accessibility of the centre of London, U.K., or of New York on regional level, the immense integral accessibility of those centres in national dimensions and the enormous integral accessibility of the same positions on a Global scale, concentrate jobs from the region, the nation and the Globe into those centres, and the population then has to live within a certain relative accessibility from these urban cores, say within daily access.

Where the integral accessibility is low, there apply Griffith Taylor's three main factors governing the distribution of mankind:- "King Cold, King Drought and King Coal". Also Wageman's "Law of alternating population densities" retains its value over the greatest part of our Globe. But in the above 120 or so places where man has created, or is creating by mechanized transport places of extremely high integral accessibility, a different, fourth factor appears to be having the upper hand, and here we might expect some help from the concepts of integral and relative accessibility.

It is not suggested that we have to desire a huge technological agglomeration in which all humanity of man is lost, although we do not know all the good, bad and indifferent results and all their combinations; "Almighty has His own purposes". It is not suggested that this trend is good, but if the urbanization of clerical and C. B. D. employment keeps intensifying and if we postulate the principle that the "power should be where the problems are ", in other words if the monstrous height of the man-made integral accessibility in the places where our metropolises spring up, is one of the chief causes of their growth into monstrous sizes, and if we attempt to enquire into the question of cities in the constitution and into problem-solution bodies of three levels of government, then a clear-cut concept of integral accessibility is a prerequisite fundamental for a handling of these questions with success.

EFFECTS OF INTEGRAL ACCESSIBILITIES

While I see the tremendous social and economic problems to be solved in a largely urbanized society, and while the concept of accessibility occupies a central position in the study of trends underlying urbanization, this brief is after all a report on the Constitution of Canada. This limits to an extent how far we can go here into this extremely interesting subject of accessibility. On the other hand it is exactly this integral accessibility which is bringing about the stresses and strains upon the framework of our Constitution by concentrating jobs in places of highest integral accessibility and thus producing the urbanization of Canada, and therewith in turn profoundly changing the structure of society of our Dominion.

It has been pointed out that there are strong economic powers in operation, directing jobs into positions of highest integral accessibility, as explained upon the last few pages of diagrams of this brief. These increased integral accessibilities stemming from the millions of horsepower which mankind is employing in ships, jumbojets, snowmobiles and other means of mechanized transportation, are thus in turn one of the chief causes lying in the ultimate analysis at the root of the increase of the urbanization of the world we live in.

The fourth and fifth page of illustrations of this Part Two, which are used also on the cover of this brief, shows the integral accessibilities resulting from the opening of the St. Lawrence Seaway, and the two diagrams upon the fifth page attempt to represent by magnets the attracting powers of integral accessibility. It ought to be mentioned here that these are the accessibilities springing from one of our most potent means of inter-connecting our Globe, that is from the strongest at present existing appliance for making places accessible, namely from shipping. A similar illustration of the N. I. A. for the private car, for rail transport and for air traffic completes the picture.

We can see two cones drawn for each one of the four cities. One cone represents the integral accessibilities before (the faint cone), the second pinnacle, the one drawn boldly shows the N. I. A. after the opening of the St. Lawrence Seaway. Not unexpectedly of course, in each case the N. I. A. after the opening of the Seaway is represented by the taller peak.

The annotations give the height of the apex in units of integral accessibility.

For Montreal most of the 7.20 units of N. I. A. shown, results of course from the proximity to the Atlantic Seaboard. The opening of the St. Lawrence Seaway has given to Montreal direct shipping access to the Great Lakes shoreline with 2.11 units of integral accessibility. The lower cones of Thunder Bay and of Chicago on the other hand are really the result of the existence of the Great Lakes system of waterways. Before the opening of the Seaway Toronto was an inland port with 2.61 units of N. I. A. The opening of the port of Toronto to ocean going shipping almost trebled the integral accessibility, rising same to 7.05 seamarks. With the opening of the St. Lawrence Seaway Toronto became an extremely accessible port of world shipping.

It is sometimes difficult to visualize which part of a cone is attracting C.B.D. employment and how these integral accessibilities are supposed to influence development. Two peaks of integral accessibility are therefore represented upon the fifth page of illustrations, each one by a magnet. The height of the magnet is drawn equal to the magnitude of integral accessibility.

DESCRIPTION OF THE EMPLOYMENT CORE OF HAMILTON

As a rule, relative accessibilities form flat-topped hillocks, such as the example upon the third page of illustrations of this Part Two. Integral accessibilities generally form pointed cones , such as the illustrations upon the last pages of this report.

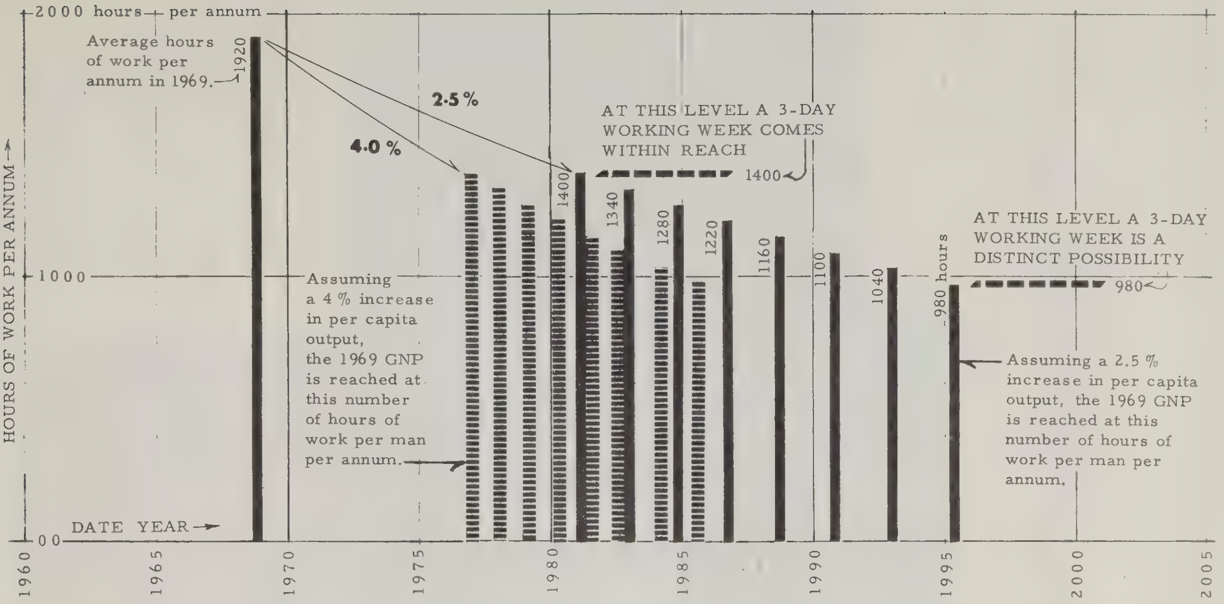
In the 19 th century the central business district of Hamilton developed at the intersection of two major roads. The focusing of the railway system of the region onto the same spot in 1854 to 1860 created a cone of integral accessibility. Said cone was subsequently slightly modified from time to time by the implementation of decisions concerning the transportation pattern. The integral accessibilities represented by the above-mentioned pinnacle became reinforced by the intra-urban transit system of Hamilton, and resulted in the cone or envelope of integral accessibilities shown upon the last page. By 1960 this envelope created by decisions of the previous generation was filled with C.B.D. employment, as can be seen upon the last page and on the last two fold-out drawings of this report.

For further details on the concepts of relative and integral accessibility please see pages 82 to 89 of Extracts from the Draft Official Plan 1970 of the City of Hamilton, Volume Two (Rapid Transit), copies of which can be obtained from the City Clerk, City Hall, Hamilton, Ontario.

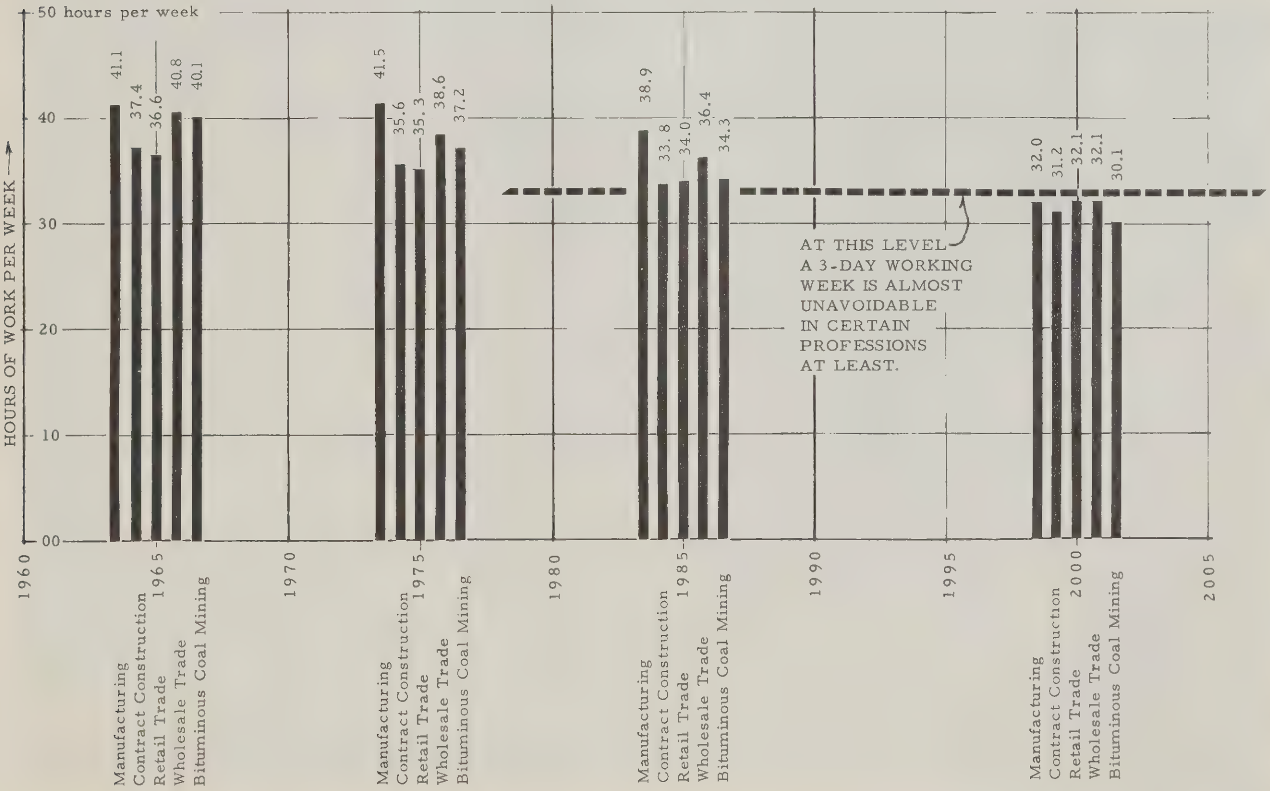
The penultimate fold-out page represents the distribution of employment throughout the City of Hamilton. The black contour lines give the density of industrial employment of 1968, in terms of number of jobs per unit area (square mile), the blue figures show the same for all employmentof 1961 around the C. B. D. The fact that we had to combine data of two periods differing by a span of seven years to obtain any picture at all, is indicative of the scarcity of detailed data on this extremely important facet of human life in our cities.

It has been pointed out in this brief that a large urban organism should have constitutional status, otherwise the Federal institutions become insensitive to local issues. For example a very high percentage of the efforts of the D. B. S. is put into analyzing night-time populations. Residential population they call it. It is the opinion of the writer, based upon his work in local planning in Cornwall and in Hamilton, that far too little of the excellent work of the D. B. S. is put into counting daytime populations, let alone classifying and analyzing distributions of jobs, such as the distribution shown on the last fold-out page, a local necessity to which a Dominion Bureau in Ottawa is less sensitive if cities like Hamilton have no constitutional status.

It will be noted in the orthogonal projection upon the lower half of the penultimate fold-out page that the manufacturing employment of Hamilton today forms a wide spread, at the comparatively low gross densities of ten to sixteen thousand jobs per square mile. This is in sharp contrast to the situation of the last century, when factories usually formed the heaviest concentrations of employment. Industrial jobs are petering out in the composition of the labour market, and at the same time new jobs, nonexistent before, such as electronic data programming are springing up at those highly accessible centres, for example at the centre of Toronto or in the C. B. D. of Hamilton depicted in detail upon the last fold-out page. Here we can observe the gross employment densities of the C. B. D. in 1961 exceeding by more than ten or fifteen times the industrial gross densities mentioned above. Thus over a longer period of time the bulk of employment seems to be having a tendency of concentrating, as mentioned previously, in those points of extremely high integral accessibility, and changing the background of the society to be framed by THE CONSTITUTION.



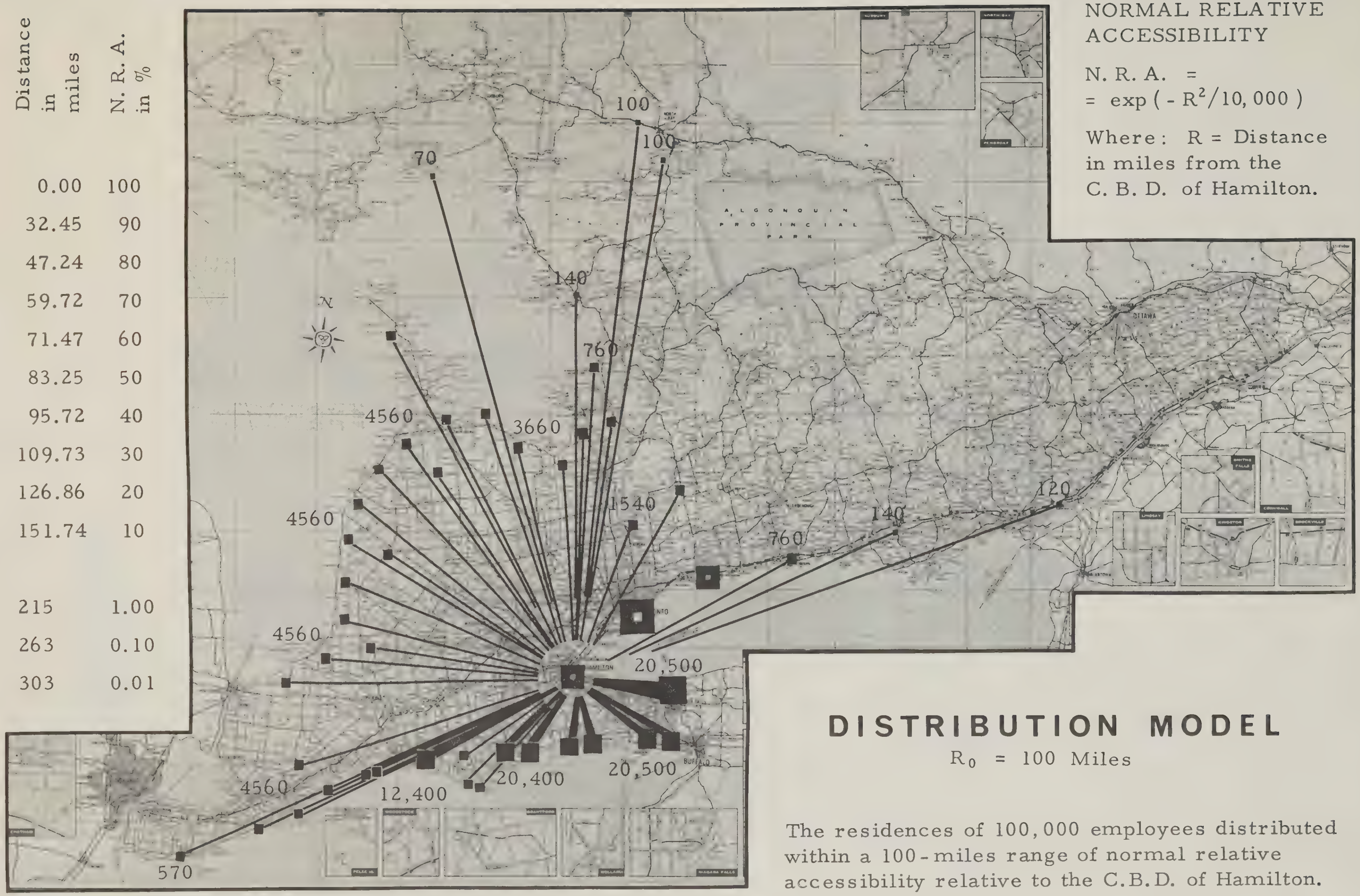
THE YEAR, AT WHICH TO-DAY'S PRODUCTION COULD BE REACHED, IN HOURS OF WORK INDICATED
Based upon the upper and lower limits of the increases of the hourly per capita output as experienced in the decades past.



AVERAGE WEEKLY HOURS OF WORK IN SELECTED INDUSTRIES
Source: Economic Report of the U. S. A. President, Jan. 1966, Table C-26, p. 24a

EMPLOYMENT TRENDS

Distance in miles	N. R. A. in %
0.00	100
32.45	90
47.24	80
59.72	70
71.47	60
83.25	50
95.72	40
109.73	30
126.86	20
151.74	10
215	1.00
263	0.10
303	0.01


100
100
70
140
760
ALGONQUIN PROVINCIAL PARK
OTTAWA
N
4560
3660
1540
4560
140
760
120
4560
HAMILTON
20,500
20,500
20,400
12,400
4560
BUFFALO
570

NORMAL RELATIVE ACCESSIBILITY

N. R. A. =
$= \exp(-R^2/10,000)$

Where: R = Distance in miles from the C. B. D. of Hamilton.

DISTRIBUTION MODEL

$R_0 = 100$ Miles

The residences of 100,000 employees distributed within a 100-miles range of normal relative accessibility relative to the C.B.D. of Hamilton.

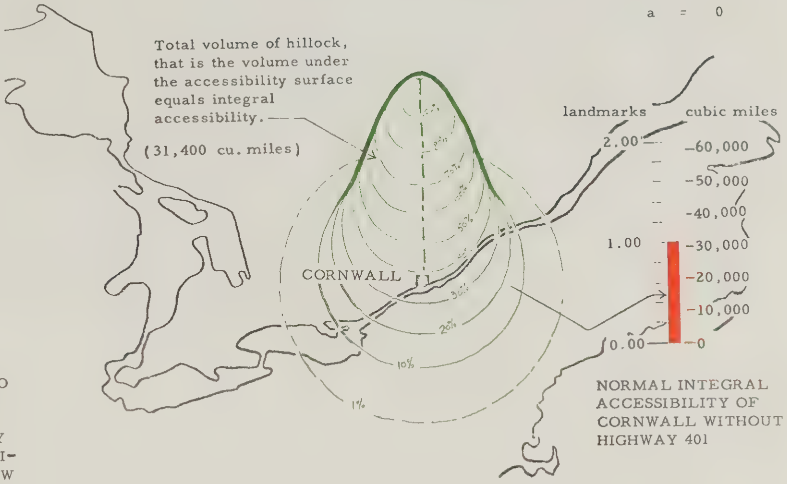
FIGURE A.2

THE CONCEPT OF INTEGRAL ACCESSIBILITY

An example chosen from the City of Cornwall, Ontario.

WE WILL CALCULATE THE VOLUME UNDER THE ACCESSIBILITY SURFACE (SEE FIGURE). THE LARGER THIS VOLUME, THE BETTER THE INTERCONNECTION OF THE POINT WITH THE SURROUNDING WORLD. THE VOLUME UNDER THE ACCESSIBILITY SURFACE THEREFORE MIGHT BE REGARDED AS THE LEVEL OF INTER-CONNECTION OF THAT POINT, A MEASURE OF INTER-CONNECTION WITH THE SURROUNDING REGION AND WITH THE WORLD AT LARGE. THIS IS THE INTEGRAL ACCESSIBILITY OF THE POINT IN QUESTION.

r_0 = 100 miles
L = 1
a = 0



Total volume of hillock, that is the volume under the accessibility surface equals integral accessibility.

(31,400 cu. miles)

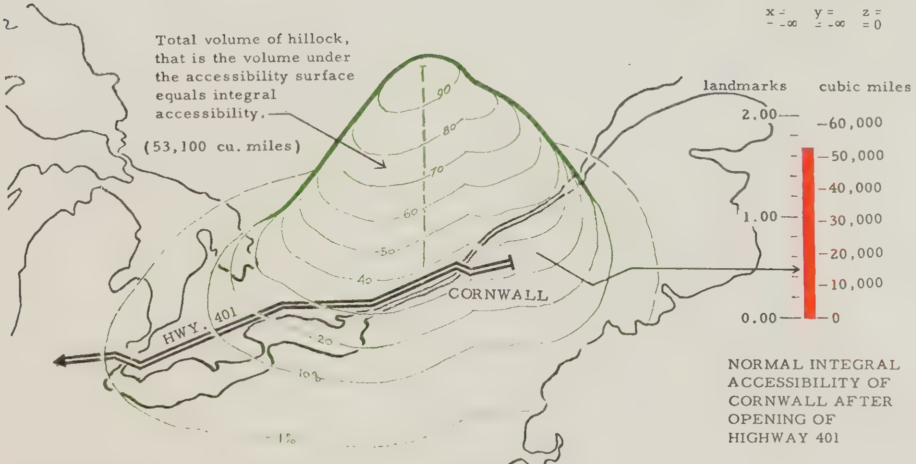
NORMAL INTEGRAL ACCESSIBILITY OF CORNWALL WITHOUT HIGHWAY 401

IN FACT WE WILL FIND THAT WE HAVE TO DISTINGUISH TWO TYPES OF CONCEPT, TWO DIFFERENT KINDS OF ACCESSIBILITY, THE THE RELATIVE ACCESSIBILITY (OF TWO POINTS) AND THE INTEGRAL ACCESSIBILITY (OF ONE POINT). THE RELATIVE ACCESSIBILITY OF TWO POINTS AS A MEASURE OF HOW INTER-CONNECTED THE TWO POINTS ARE WITH EACH OTHER OR HOW ACCESSIBLE THE THE TWO POINTS ARE FROM EACH OTHER, THE INTEGRAL ACCESSIBILITY OF A POINT AS A MEASURE OF HOW INTER-CONNECTED THAT POINT IS WITH THE REST OF THE WORLD,

WE CAN EXPRESS IN CUBIC MILES THE VOLUME UNDER THE SURFACE OF ALL RELATIVE ACCESSIBILITIES (RELATIVE TO POINT "k"). THIS WILL GIVE THE INTEGRAL ACCESSIBILITY OF THAT POINT IN CUBIC MILES.

INTEGRAL ACCESSIBILITY IN CUBIC MILES:

$$\text{N. I. A.} = \int_{x=-\infty}^{+\infty} \int_{y=-\infty}^{+\infty} \int_{z=0} \exp -\left[\left(\frac{a+c}{r_0}\right)^2 + \left(\frac{b}{Lr_0}\right)^2 \right] dx\, dy\, dz$$



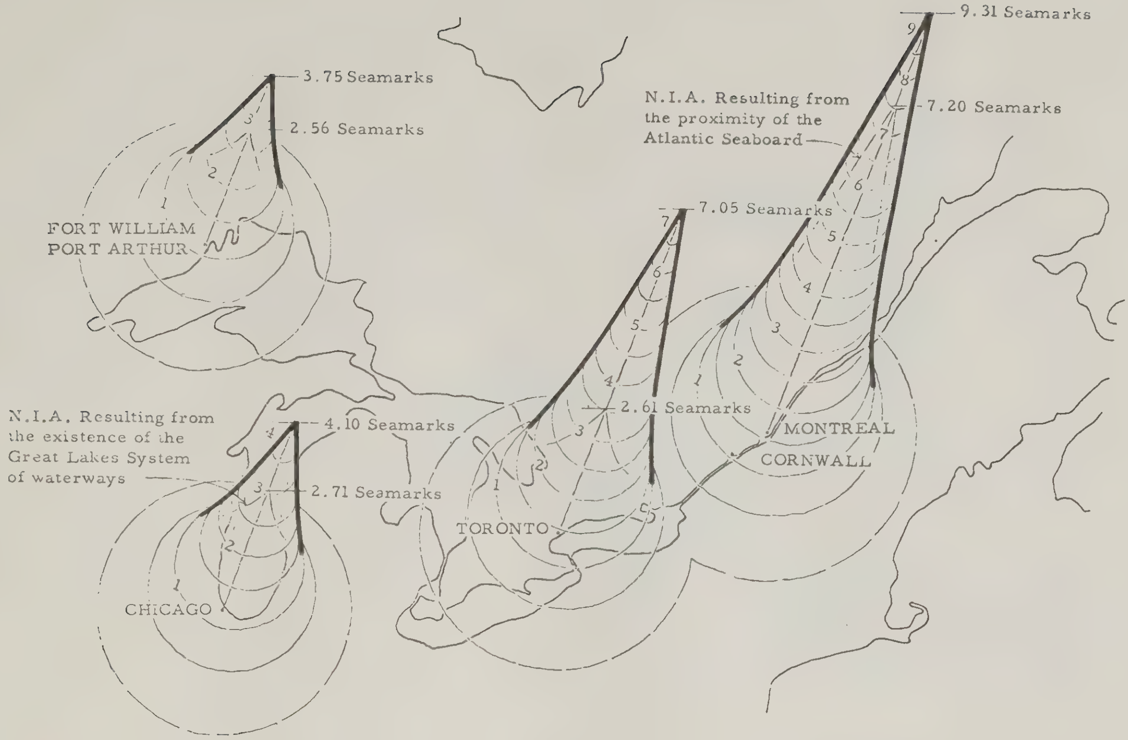
Total volume of hillock, that is the volume under the accessibility surface equals integral accessibility.

(53,100 cu. miles)

NORMAL INTEGRAL ACCESSIBILITY OF CORNWALL AFTER OPENING OF HIGHWAY 401

r_0 = 100 miles
L = 3
a = 0

TO THE MATHEMATICAL READER WE CAN SAY, THAT THE INTEGRAL ACCESSIBILITY OF A POINT IS ESSENTIALLY A SCALAR POINT FUNCTION, DEFINED BY THE INTEGRAL OF ITS RELATIVE ACCESSIBILITIES.

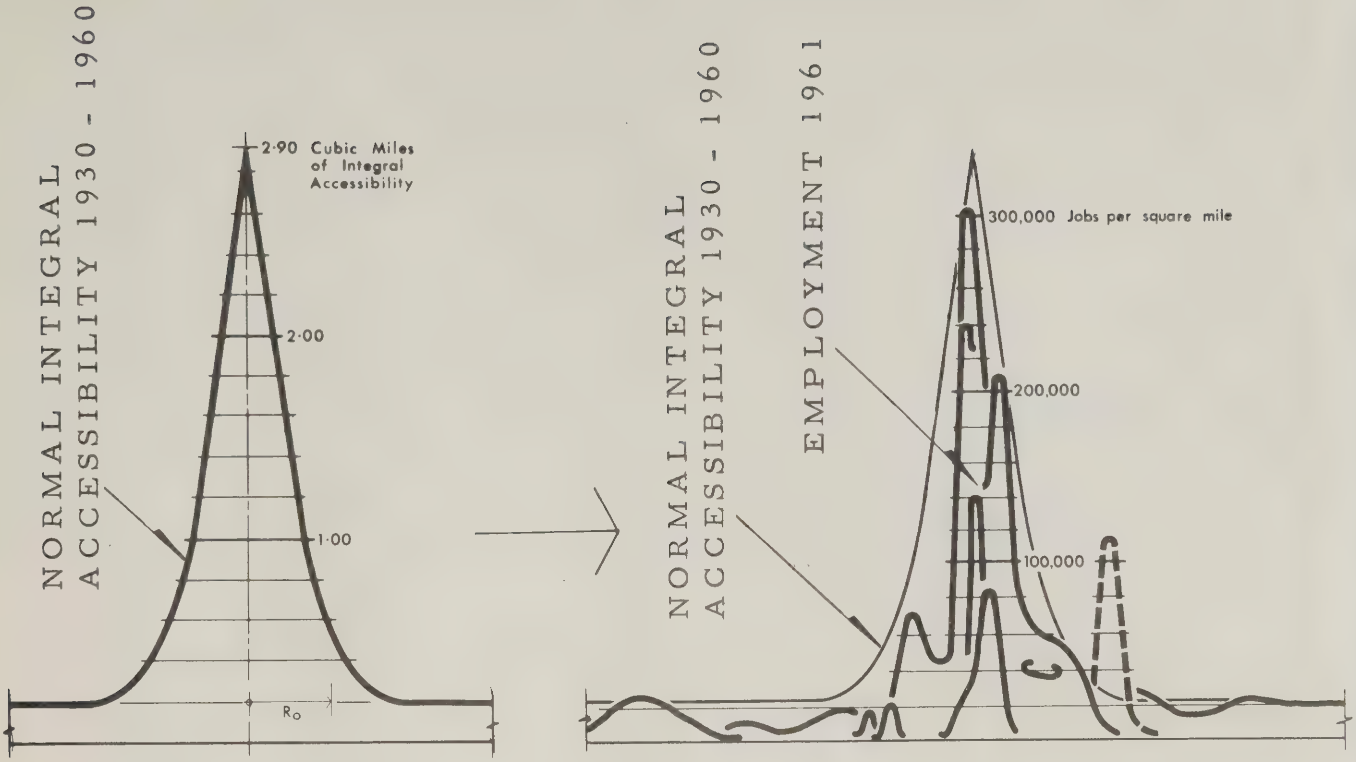

3.75 Seamarks
2.56 Seamarks
FORT WILLIAM
PORT ARTHUR
N.I.A. Resulting from the proximity of the Atlantic Seaboard
9.31 Seamarks
7.20 Seamarks
7.05 Seamarks
2.61 Seamarks
MONTREAL
CORNWALL
N.I.A. Resulting from the existence of the Great Lakes System of waterways
4.10 Seamarks
2.71 Seamarks
TORONTO
CHICAGO

INTEGRAL ACCESSIBILITIES

$L = 20, \quad R_0 = 100$ Miles
Resulting from Shipping.

It has been pointed out, that there are strong economic powers in operation, directing jobs into positions of highest integral accessibility. Thus, in the ultimate analysis, N. I. A. would appear at the root of the growing urbanization of the world we live in. The above illustration, used also on the cover, shows the integral accessibilities generated by shipping. The N. I. A. for other means of transportation would complete the picture. The two magnets upon the following page depict the changes of the attracting powers resulting from the opening in June 1959 of the St. Lawrence Seaway.

We can see two cones drawn for each one of the four cities. One pinnacle portrays the integral accessibilities before, the other apex the N. I. A. after the opening of the St. Lawrence Seaway. Not unexpectedly of course, in each case the N. I. A. after the opening of the Seaway is represented by the taller peak. The annotations give the height of the summit in units of integral accessibility. It is sometimes difficult to visualize which part of a cone is attracting C. B. D. employment, and how these integral accessibilities are supposed to influence development. Two of the peaks of integral accessibility from the above illustration are therefore represented upon the following page, each one by a magnet. The height of the magnet is drawn equal to the magnitude of integral accessibility.


NORMAL INTEGRAL ACCESSIBILITY 1930 - 1960
2·90 Cubic Miles of Integral Accessibility
2·00
1·00
R₀
NORMAL INTEGRAL ACCESSIBILITY 1930 - 1960
EMPLOYMENT 1961
300,000 Jobs per square mile
200,000
100,000

Relative accessibilities, as a rule, form flat-topped hillocks, such as the example on a previous page, integral accessibilities generally form pointed cones, such as the figure above, or such as the illustration on the cover of this report.

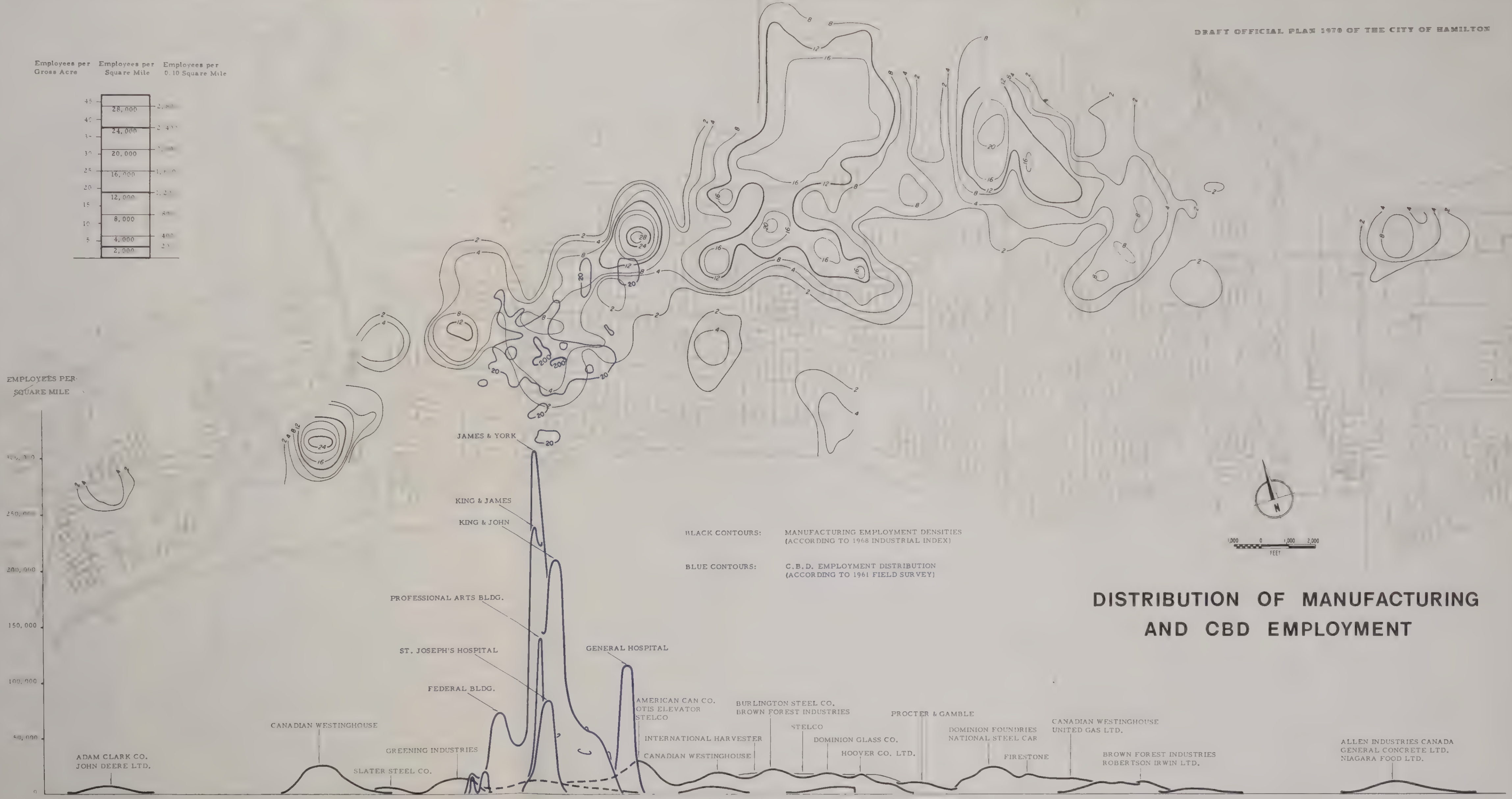
In the 19th century the Central Business District of Hamilton developed at the intersection of two major roads. The focusing of the railway system of the region onto the same spot in the years 1854 to 1860, created a cone of integral accessibility. Said cone was subsequently slightly modified from time to time by the implementation of decisions concerning the transportation pattern. The integral accessibility represented by the cone became also reinforced by the inter-urban transit system of Hamilton, and resulted in the cone (or envelope) of integral accessibilities shown above on the left. By 1960, this envelope created by the former generation, was filled by C. B. D. employment, as can be seen above on the right.

For further details on the concepts of relative and of integral accessibility please see pages 82 to 89 of Extracts from the Draft Official Plan 1970 of the City of Hamilton, Volume Two (Rapid Transit), copies of which can be obtained from the City Clerk, City Hall, Hamilton, Ontario.

ACCESSIBILITY AND CBD EMPLOYMENT

HORIZONTAL SCALE: 4400 FEET = 1 INCH

DISTRIBUTION OF MANUFACTURING AND CBD EMPLOYMENT


Employees per Gross Acre
Employees per Square Mile
Employees per 0.10 Square Mile
45
40
35
30
25
20
15
10
5
28,000
24,000
20,000
16,000
12,000
8,000
4,000
2,000
2,800
2,400
2,000
1,600
1,200
800
400
200
EMPLOYEES PER SQUARE MILE
300,000
250,000
200,000
150,000
100,000
50,000
0
JAMES & YORK
KING & JAMES
KING & JOHN
PROFESSIONAL ARTS BLDG.
ST. JOSEPH'S HOSPITAL
FEDERAL BLDG.
GENERAL HOSPITAL
ADAM CLARK CO.
JOHN DEERE LTD.
CANADIAN WESTINGHOUSE
SLATER STEEL CO.
GREENING INDUSTRIES
AMERICAN CAN CO.
OTIS ELEVATOR
STELCO
INTERNATIONAL HARVESTER
CANADIAN WESTINGHOUSE
BURLINGTON STEEL CO.
BROWN FOREST INDUSTRIES
STELCO
DOMINION GLASS CO.
HOOVER CO. LTD.
PROCTER & GAMBLE
DOMINION FOUNDRIES
NATIONAL STEEL CAR
FIRESTONE
CANADIAN WESTINGHOUSE
UNITED GAS LTD.
BROWN FOREST INDUSTRIES
ROBERTSON IRWIN LTD.
ALLEN INDUSTRIES CANADA
GENERAL CONCRETE LTD.
NIAGARA FOOD LTD.
2
4
8
12
16
20
24
28
200
N
1,000
0
1,000
2,000
FEET

BLACK CONTOURS: MANUFACTURING EMPLOYMENT DENSITIES (ACCORDING TO 1968 INDUSTRIAL INDEX)

BLUE CONTOURS: C.B.D. EMPLOYMENT DISTRIBUTION (ACCORDING TO 1961 FIELD SURVEY)

CITY OF HAMILTON PLANNING DEPARTMENT
May 1969, First Edition

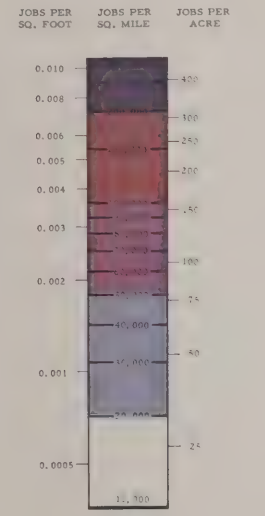
DRAFT OFFICIAL PLAN 1970 OF THE CITY OF HAMILTON

1961

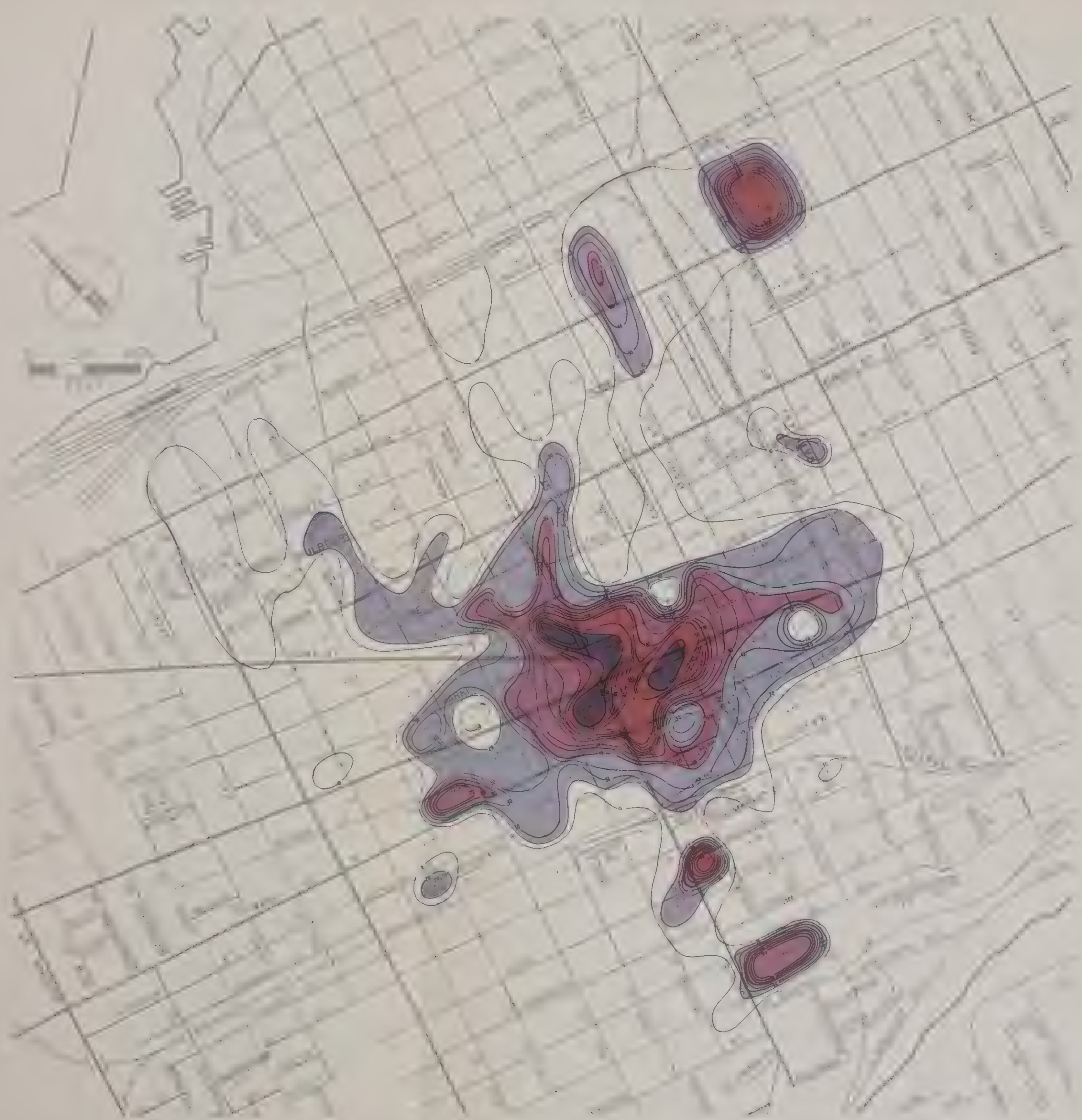
EMPLOYMENT DENSITY DISTRIBUTION

JOBS PER SQUARE MILE

DOWNTOWN AREA

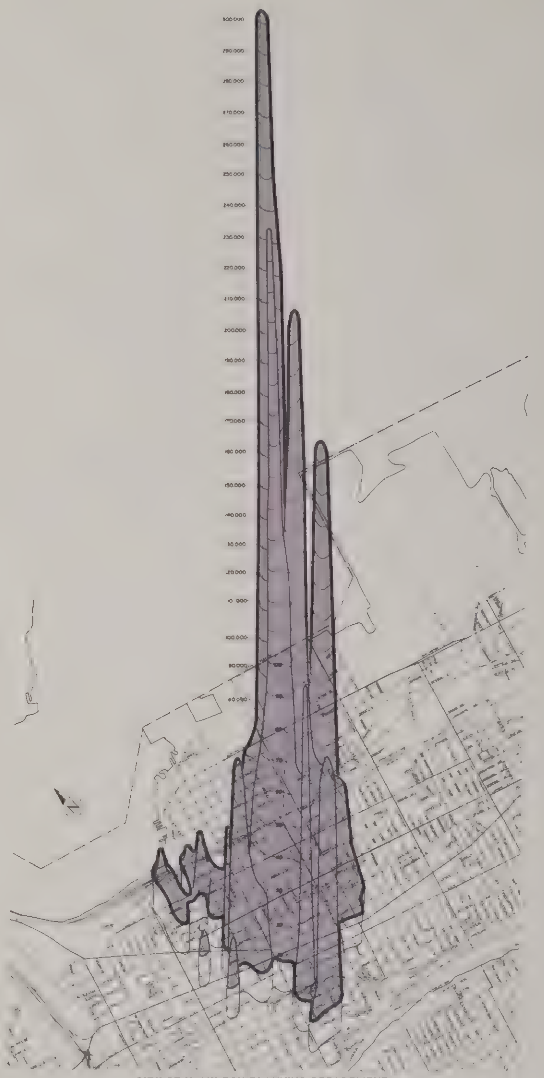


CONVERSION SCALE



THE CONCENTRATION OF EMPLOYMENT OPPORTUNITIES, PARTICULARLY IN THE CENTRAL CORE AREA, IS READILY APPARENT. EACH CONTOUR VALUE REPRESENTS JOBS PER SQUARE MILE IN THOUSANDS AND ONLY DENSITIES OF 10,000 AND GREATER ARE ILLUSTRATED. EMPLOYMENT WITHIN THIS LATTER PROJECTED AREA CONSTITUTES 22.5 PERCENT OF THE EMPLOYMENT IN HAMILTON. THE RELATIVE INTENSITY OF THE CORE AREA DENSITIES IS PLOTTED IN THE VERTICAL DIMENSION ON THE RIGHT.

L. J. L.



CITY OF HAMILTON PLANNING DEPARTMENT
November 1968, First Edition

APPENDIX

OTTO C. A. LANGMARK
Dip. T.P. (Sydney), Dipl. Ing. Arch. (Berlin),
F.R.A.S.

360 Torrance Street, Apt. 1408,
BURLINGTON, Ontario,

16 th of January, 1971.

The Honourable Members of the Special Joint Committee
of the Senate and the House of Commons
on the Constitution of Canada.

Dear Sirs:

The kind interest of a number of the Honourable Members shown at the public hearing in December, 1970 on the subject matter of my submission about the problems brought upon our Constitution by the increasing urbanization of Canada, encourages me to attach this more complete report as an appendix to the Background Material of my submission, because the material used in my presentation consisted in essence really of a condensation of selected suitable parts of this document. Perhaps the Honourable Members might wish to refer to pages 72 to 76 for an expose on the concepts of integral and relative accessibility, or to pages 105 to 129 for some examples of the effects of said accessibilities.

Yours very truly,

O. C. A. LANGMARK

THE CONCEPT OF ACCESSIBILITY

AN

APPENDIX

TO THE BRIEF OF OTTO C. A. LANGMARK
ON THE CONSTITUTION OF CANADA

PRELIMINARY ACKNOWLEDGMENTS
TO THE SECOND EDITION

This is part of a larger work originated jointly at the Cumberland County Council, Australia, and the dept. of Town and Country Planning, University of Sydney, N.S.W., Professor Denis Winston, M.A., B.Arch., M.T.P.I., F.R.I.B.A., F.I.L.A.,

Computations on the electronic computer SILLIAC, of the Adolph Basser Computing Laboratory, University of Sydney, N.S.W., (Dec.,1957 to Mar.,1958),

The whole responsibility however, particularly for mistakes or for opinions expressed rests with the author.

Further acknowledgment is due to the following, whose kind cooperation helped the author to present the subject to an extensive expert audience:

M. Crossland Esq., M.T.P.I., and Alfred R. Potter Esq., O.B.E., Hon.M.T.P.I. of the Town Planning Summer Schools Southampton and St. Andrews (Sept., 1959 and Sept., 1960),

R. J. Smeed Esq., B.Sc., Ph.D., F.S.S., A.I.C.E., for an excellently organized lecture at the Road Research Laboratory, Langley, U.K. (Nov., 1961),

Colin D. Buchanan Esq., B.Sc.(Lond.), A.M.I.C.E., A.M.T.P.I., then Urban Adviser of the Min. of Transport, Great Britain, whose extensive contacts helped the above,

Prof. Erich Kühn, B.D.A., A.F.S., and his staff at the dept. of Town and Regional Planning, University Aachen, W. Germany, for organizing a lecture and seminar, in which some of the basic, underlying principles could be expostulated with the students (Dec., 1961).

My gratitude is due to Mrs. Judy Fitz-Henry M.A., M.A.P.I., Sydney, Australia, and to Mr. Morris Taylor M.A., A.M.T.P.I., Christchurch, New Zealand, for reading and correcting the manuscript, and last but not least to Mr. Eric Collen of Sir John Burnet Tait & Partn., Architects, London, Great Britain, for devizing the technical means of producing the first, limited edition of copies (1959).

This second edition is essentialy volume two (of five volumes) of the first edition, somewhat modified, to suit the requirements of our St. Lawrence Seaway City, Cornwall.

The following gentlemen, on the mathematical side Mr. Peter Hochla, Oklahoma City University, Mathematics and Physics, Mr. Mackenzie Smith, of Queen's University, Kingston, Mathematics and Physics; on the graphical side Mr. Speros Christopoulos, of McGill University, Montreal, Architecture, Mr. Christopher Knowles, University of Toronto, Architecture, and Mr. Ernest Varvarikos, of McGill University, Montreal, Architecture, applied themselves assiduously to the task of preparing from preliminary calculations of the Adolph Basser Computing Laboratory, Sydney University mentioned above, (and which still, on occasions form the backbone of many an important decision or solution in my work), to the preparation of what resulted in diagrams UP2-01, 02, 03, 04 and 09 of this edition of extracts.

Acknowledgment is due to the Architects' Journal 20th of April, 1961, 10th of April, 1963, and 4th of September, 1963, and the Architect and Building News 18th of December, 1963, in Great Britain, for publishing some extracts and diagrams from the first edition.

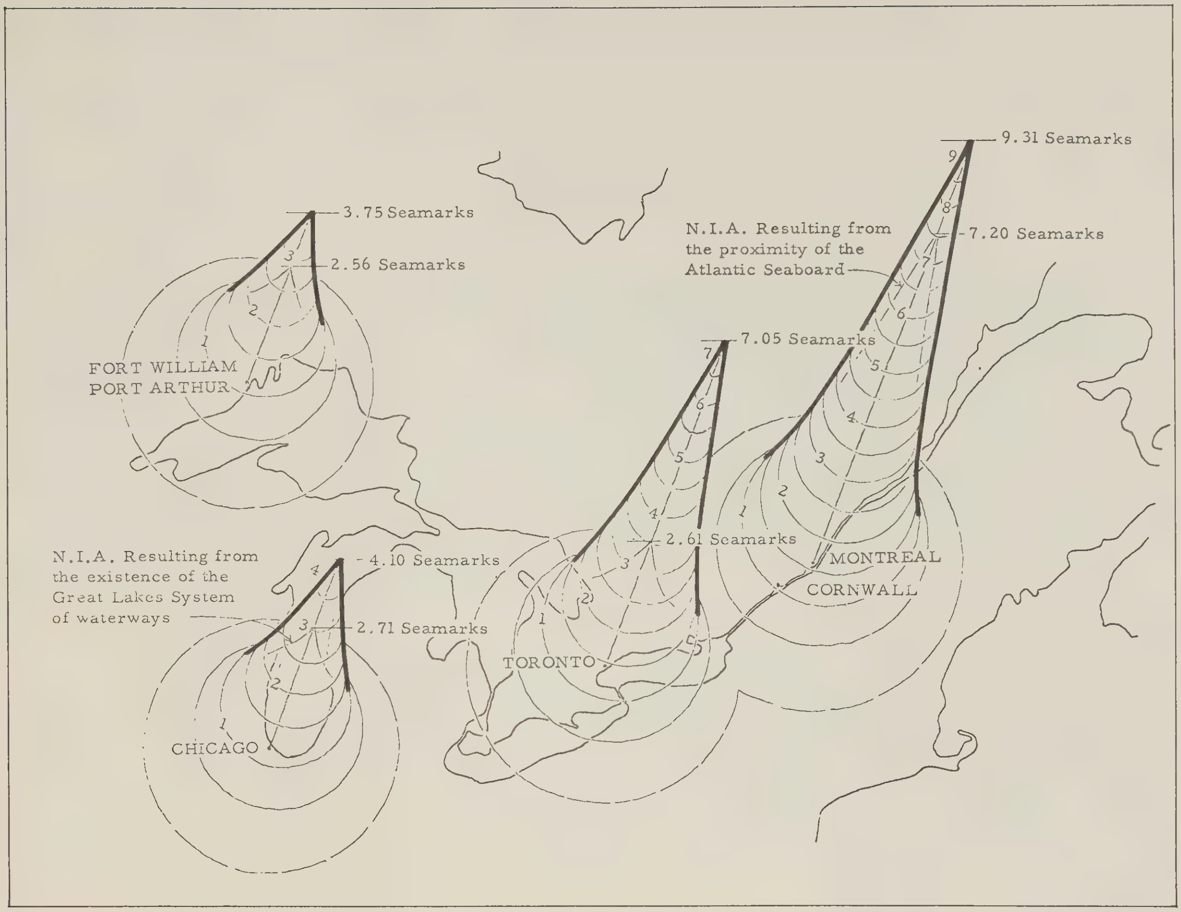
My thanks are due to Mrs. Mavis Short, for her unbounded patience with the task, exasperating sometimes, of producing the typescript, to Miss Jurate Janusas, who helped on occasions when Mrs. Short was not available, and to Miss Ann Tobin, for her care in reading some of the proofs.

Greatly indebted am I also to our consultant, Professor Kent Barker of the University of Toronto, to John R. James Esq., of the Min. of Housing and Local Gov. in Great Britain, and to all those numerous colleagues of mine who helped with encouragement. In brief, the only one to whom the author does not thank is himself, for believing at the outset, that a job like this one could be knocked together in the short span of a year or two.

P. O. Box 337,
Cornwall, Ontario,

Otto Langmark

O.C.A.LANGMARK,
Copyright 1968.


9.31 Seamarks
7.20 Seamarks
N.I.A. Resulting from the proximity of the Atlantic Seaboard
3.75 Seamarks
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TORONTO
N.I.A. Resulting from the existence of the Great Lakes System of waterways
4.10 Seamarks
2.71 Seamarks
CHICAGO

OTTO C. A. LANGMARK

THE CONCEPT OF ACCESSIBILITY

PREFACE

Our Globe is now laced with transport routes. The areas of our world have become very accessible from each other, with great consequences to mankind. Is it not therefore remarkable how little research has been done into the extremely interesting subject of accessibility? Of many transport investigations much is useless here, because in transport we are all the time thinking upside down, the more transport necessary to get there the less accessible and vice versa, and as a result even august bodies appear in difficulties with questions of accessibility.

Modern, mechanized communications exert by their pattern of accessibilities powers of the character of natural laws upon society. We are employing millions of horsepower in machines to make certain places very accessible, and the aim of our (main) work is to elucidate the nature of these laws of accessibility, to expose on examples what is accessible and what is inaccessible, what is more accessible and what is less and why.

The aim of this abbreviation is to present to the less technical reader a short picture by selecting typical instances from our main work. This condensation contains only that part which in a highly mechanized society every serious student of Architecture, Civil Engineering, Economics, Geography, Surveying or Town Planning, as well as all those connected with the management of public affairs should know about accessibility.

It took the author fifteen years to abbreviate the matter, and the reader who has no time might be happiest reading the last pages only. Even if we are unable to offer there anything of the underlying principles, at least you will find in the epilogue one or two of the main ideas of this work presented in a readable form. As today everybody seems to come into contact with transport, we hope this extract will encourage the more intelligent reader, to form his own opinions on the subject, and to make his own observations on ACCESSIBILITY.

UP2 - 1

INTRODUCTION

Economic Implications

INTRODUCTION

(Accessibility an inverse of transport,
some influences of accessibility).

The Matterhorn can be climbed by various routes. Some lines to the summit are fairly easy, other climbs difficult. The Brains Trust of the famous Town Planning Summer Schools speaks of a "complicated question on the nature of accessibility and its influence upon development" which "led the team upon several varying lines of thought".

Why did some members of such a distinguished gathering find it difficult to handle questions on accessibility? Perhaps they were thinking traditionally in terms of transport, and the reader will appreciate the difficulties of these conventional methods if he observes, that in transport we are thinking all the time upside down

(or perhaps better downside up). It is as if we had somebody prepare the budget of our department, but instead of listing the items:

£ 3000	for own salary,
2000) 1000)	" salary of staff,
592	for typing,
8	petty cash,

we would have him book:

£ 1	for own salary,
183) 3679)	" salary of staff,
7059	for typing,
10000	for petty cash.

(The more important the item, the smaller the figure). Of course we also would learn to manage, particularly in simpler cases, but why this mental exercise? With transport and accessibility the situation is very similar; the more transport necessary to get there, the less accessible and vice versa.

In an isolated neighborhood we might see our way even in this inverse, but there it is perhaps unimportant, we almost need it not. It is just where we have made our accessibilities complex, with huge peaks, depressions and overlaps, like in our metropolises and their connections to the surrounding world, there we can expect some help from the concept of accessibility. In thinking in terms of transport the viewing point of our perspective is chosen so disadvantageously, that it reveals nothing of the main masses of the building.

And then we have said nothing of tariff policy, legal restrictions to travel and import, etc., which all have a strong bearing on accessibility, but are not necessarily a direct matter of transport. I think of the accessibility of London to people from Jamaica or from say, Malaya, and the inaccessibility of London to inhabitants of Puerto Rico. Or the inaccessibility of New York to Jamaicans, and the accessibility of New York to citizens of Puerto Rico, with all the resulting consequences which you can clearly observe in London, in Sydney, or in Singapore.

The reader might perhaps know better than the writer how directly land values are tied up with accessibility, and this in turn reflects (or at least should reflect) on questions of betterment, and to a lesser extent on compensation too. Indeed it were some strange conceptions in the Uthwatt Report, which made the author finally bite into this sour apple of accessibility, ~~because~~ Most of the statements of this said Uthwatt Report are acceptable only if we assume that no such thing as integral accessibility exists.

It was not zoning that squeezed prices of land at the centre of London into heights, and I dare say, that it was not even the volume of cultural establishments. At the centre of Sao Paulo, in Brazil, there are (as yet!) not many cultural establishments or government offices, but there is a high accessibility. Canberra, on the other hand, where the creation of a good accessibility was forgotten, has made little headway, although there are government offices, university- and cultural establishments. Canberra was selected because of its more favourable climate, yet business is concentrating at the centre of Sydney, which is very accessible from all of New South Wales. The better climate of the South has been offered to the writer at the T.P. Summer School Southampton as a chief reason for the attraction toward the centre of London. Why does Cornwall with a similar climate exercise no such attraction?

There is a drift from the rest of the United Kingdom and from the Globe at large, to the centre of London, where there is a high integral accessibility, and also government offices. I was told at the 1959 Town Planning Summer School, that a London address is worth so many thousand pounds a year. But a New York address is worth to a firm equally as much, and New York has no government offices, but again a huge accessibility.

It is probably not even the volume of buildings that gives us the clue. After the war most of the volume of buildings was destroyed in some countries. Yet there, where the city was extremely accessible from the surrounding region, a new core grew up quickly at the (extremely accessible) centre. In St.Louis, U.S.A., I suspect the opposite is probably the case. The centre is no longer very accessible, and even a great volume of buildings can not stop decay.

Of course the existence of fine and historically popular buildings like in Rome or in Sienna also has its influence. So has the existence or nonexistence of zoning laws. Nevertheless it is probably true to say, that the cores of huge metropolises the world over, are created by huge accessibility in that spot.

The existence or nonexistence of an inaccessible ring around the highly accessible core of some metropolises like in Sydney, or London, with its strictly concentrating effect on private business there, is a further point apparent even in a most crude investigation on accessibility, but not manifest if we look in terms of transport only.

We have given great attention to this matter at the University of Sydney, N.S.W., and it seems no exaggeration to say that accessibility can do much. So let us hope that the subject will gradually attract both, the strongest characters and the sharpest thinkers. Our best thinkers to clarify the scientific issues involved, and our strongest personalities to create the required patterns of accessibility.

UP2 - 2

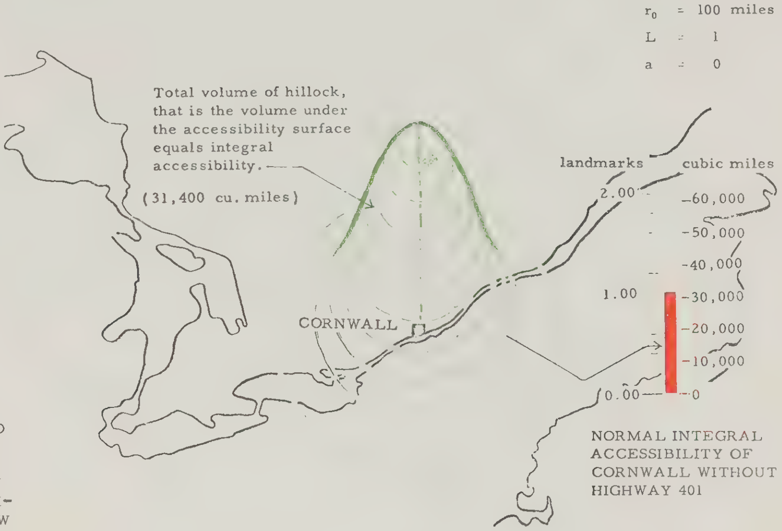
UNDERLYING IDEAS

FIGURE A.2

THE CONCEPT OF INTEGRAL ACCESSIBILITY

An example chosen from the City of Cornwall, Ontario.

WE WILL CALCULATE THE VOLUME UNDER THE ACCESSIBILITY SURFACE (SEE FIGURE). THE LARGER THIS VOLUME, THE BETTER THE INTERCONNECTION OF THE POINT WITH THE SURROUNDING WORLD. THE VOLUME UNDER THE ACCESSIBILITY SURFACE THEREFORE MIGHT BE REGARDED AS THE LEVEL OF INTER-CONNECTION OF THAT POINT, A MEASURE OF INTER-CONNECTION WITH THE SURROUNDING REGION AND WITH THE WORLD AT LARGE. THIS IS THE INTEGRAL ACCESSIBILITY OF THE POINT IN QUESTION.


r_0 = 100 miles
L = 1
a = 0
CORNWALL
landmarks
cubic miles
2.00
1.00
0.00
60,000
50,000
40,000
30,000
20,000
10,000
0

Total volume of hillock, that is the volume under the accessibility surface equals integral accessibility.

(31,400 cu. miles)

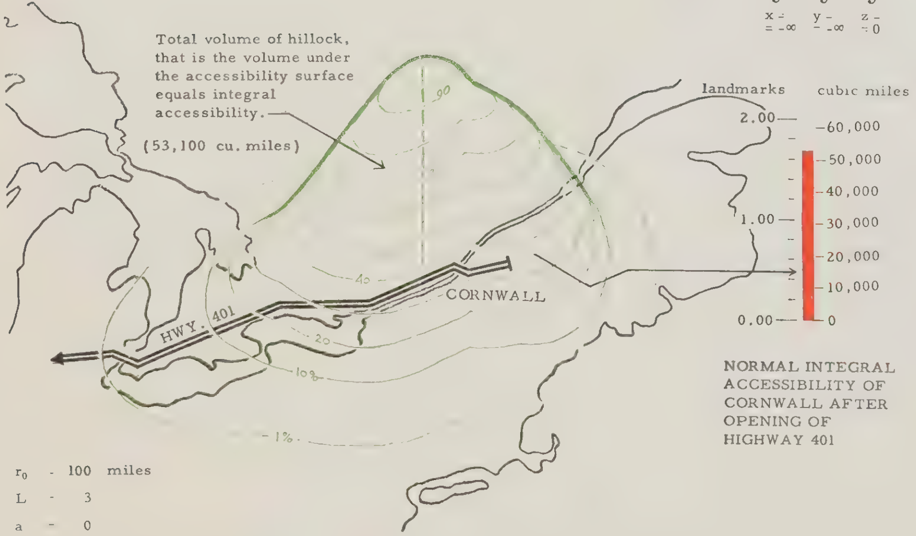
NORMAL INTEGRAL ACCESSIBILITY OF CORNWALL WITHOUT HIGHWAY 401

IN FACT WE WILL FIND THAT WE HAVE TO DISTINGUISH TWO TYPES OF CONCEPT, TWO DIFFERENT KINDS OF ACCESSIBILITY, THE THE RELATIVE ACCESSIBILITY (OF TWO POINTS) AND THE INTEGRAL ACCESSIBILITY (OF ONE POINT). THE RELATIVE ACCESSIBILITY OF TWO POINTS AS A MEASURE OF HOW INTER-CONNECTED THE TWO POINTS ARE WITH EACH OTHER OR HOW ACCESSIBLE THE THE TWO POINTS ARE FROM EACH OTHER, THE INTEGRAL ACCESSIBILITY OF A POINT AS A MEASURE OF HOW INTER-CONNECTED THAT POINT IS WITH THE REST OF THE WORLD.

WE CAN EXPRESS IN CUBIC MILES THE VOLUME UNDER THE SURFACE OF ALL RELATIVE ACCESSIBILITIES (RELATIVE TO POINT "k"). THIS WILL GIVE THE INTEGRAL ACCESSIBILITY OF THAT POINT IN CUBIC MILES.

INTEGRAL ACCESSIBILITY IN CUBIC MILES:

$$\text{N. I. A.} = \int_{x=-\infty}^{+\infty} \int_{y=-\infty}^{+\infty} \int_{z=0} \exp -\left[\left(\frac{a+c}{r_0}\right)^2 + \left(\frac{b}{Lr_0}\right)^2 \right] dx\, dy\, dz$$


90
40
20
10%
1%
HWY. 401
CORNWALL
landmarks
cubic miles
2.00
1.00
0.00
60,000
50,000
40,000
30,000
20,000
10,000
0
r_0 - 100 miles
L - 3
a - 0

Total volume of hillock, that is the volume under the accessibility surface equals integral accessibility.

(53,100 cu. miles)

NORMAL INTEGRAL ACCESSIBILITY OF CORNWALL AFTER OPENING OF HIGHWAY 401

TO THE MATHEMATICAL READER WE CAN SAY, THAT THE INTEGRAL ACCESSIBILITY OF A POINT IS ESSENTIALLY A SCALAR POINT FUNCTION, DEFINED BY THE INTEGRAL OF ITS RELATIVE ACCESSIBILITIES.

THE CONCEPT OF ACCESSIBILITY
UNDERLYING IDEAS

The concept of accessibility is neither carnations nor apples, it is a concept. Like the notion of a distance or the idea of temperature, the concept of accessibility is a species of its own and in fact we will find that we have to distinguish two types of concept, two different kinds of accessibility, the relative accessibility (of two points) and the integral accessibility (of one point). The relative accessibility of two points as a measure of how inter-connected the two points are with each other or how accessible the two points are from each other, the integral accessibility of a point as a measure of how inter-connected that point is with the rest of the world.

Now it would be inconvenient to gauge distances in degrees of Fahrenheit or temperatures in ounces. Similarly, we need one special unit to measure our relative accessibility and another unit to measure our integral accessibility, and to say it straight away we will measure the relative accessibility in percents and the integral accessibility in seamarks and landmarks.

We will say that the point we are in at a given moment is to us 100% accessible, that is, its relative accessibility (relative to itself) is 100%. For example, if we will speak of the relative accessibilities, relative to Balmoral Beach, Sydney, we will say that the relative accessibility of any other place in the world (relative to Balmoral Beach) is a greater or smaller part of 100% according to whether it is easier or more difficult to get there from Balmoral Beach. The reasons why some places might be less accessible from Balmoral Beach are, of course, numerous. For example: time necessary to get there, cash involved, legal restrictions to travel or import, capacity of transport system, etc.

To the mathematical reader we can say that the relative accessibility is in principle a frequency function, with the mode in the point of departure or arrival.

The measurement of integral accessibility is, unfortunately, a little more involved. It is not absolutely

necessary to know more about the unit of integral accessibility at this stage, but it requires only a little additional effort, and it helps to complete the picture. We will calculate the volume under the accessibility surface((see fig. UP2 - 1). The larger this volume, the better the inter-connection of the point with the surrounding world. The volume under the accessibility surface therefore might be regarded as the level of inter-connection with the surrounding region, and we will say that a point has an integral accessibility of one landmark, if it is as inter-connected with the world as our standard. We shall say that a point has an integral accessibility of one cubic mile, if this point is so inter-connected with the rest of the world, that say 10 square miles of the world are each 10 % accessible and all the other square miles of the world zero % accessible from our point, or alternatively, if from our point one square mile were 100 % accessible.

It has proved important for clarity of thought, to have two versions of the same-size unit, seamarks where sea transport is involved, landmarks where it is not. Seamarks and landmarks are not freely interchangeable, and the situation bears often resemblance to mathematical functions of a complex variable, we have several different values for the same point, and seamarks and landmarks must not be freely mixed. The integral accessibility in seamarks is in many important cases the larger one by far. (See fig. 007 of the main report).

Once we then have the relative accessibilities and the integral accessibility of a point, it is, of course, a simple and easy matter to multiply it by the capital investment within its reach, the number of jobs, the population figures, the industrial output, the agricultural production or any other factor we happen to be concerned with at the given moment.

To the mathematical reader we can say that the integral accessibility of a point is essentially, a scalar point function, defined by the integral of its relative accessibilities.

To illustrate - we might find, for example, that the integral accessibility of the core of a metropolis like Melbourne or Buenos Aires might be, say 2,000 cu. miles , because 10,000 square miles may be found 20% accessible. We might find that the integral accessibility of the North tip of Hayman Island in the Great Barrier Reef is only 0.4 cu. mls., because only 2 square miles are 20% accessible. Or again, the integral accessibility of an advantageously located neighborhood shopping establishment might be 1.5 cu. miles,

[illegible] ready to know more about the [illegible]
[illegible] but it requires only a little [illegible]
[illegible] complete the picture. [illegible]

[illegible] volume, the better the inter-connection of the [illegible]
[illegible] rounding world. The volume [illegible]
therefore must be regarded as the [illegible]
the surrounding region, and we will say that a [illegible]

[illegible] with the world as our standard. We shall say that [illegible]
[illegible] integral accessibility of one cubic mile [illegible]
[illegible] inter-connected with the rest of the world, [illegible] 10 square
[illegible] les of the world are each 10 % accessible [illegible]
square miles of the world zero % accessible from [illegible]
[illegible] respectively, if from our point one square mile [illegible]

It has proved important for clarity of [illegible], to ha-
[illegible] two versions of the same-size unit, seamarks where [illegible]
[illegible] is involved, landmarks where it is not. Seamarks and land-
marks are not freely interchangeable, and the situation bears [illegible]
[illegible] resemblance to mathematical functions of a complex varia-
[illegible] we have several different values for one same point, [illegible]

[illegible] accessibility in seamarks is in many important cases [illegible]
[illegible] (See fig. [illegible] of the main report.)

Once we then have the relative accessibilities [illegible]
[illegible] integral accessibility of a point, it is, of course, [illegible]
[illegible] matter to multiply it by the capital invested [illegible]

[illegible], the agricultural production or any other [illegible]

[illegible] the mathematical [illegible]
[illegible] of a point to continuity [illegible]
[illegible] the integral of its relative [illegible]

[illegible] illustrate - we might [illegible]
[illegible] integral accessibility of the core of [illegible]
[illegible] Buenos Aires might be [illegible]

[illegible] and that the integral accessibility [illegible]

only 2 square miles [illegible]
[illegible] integral accessibility of [illegible]

because 3 square miles are found to be 50% accessible. Or a cornerstone, like Singapore, might have an integral accessibility of many thousand seamarks, but only few landmarks. The town planner is, of course, usually more interested in the landmarks, the British Admiralty might be more interested in the seamarks of Singapore. Again, the yachtsmen competing in the Sydney to Hobart Yacht Race are most concerned with the relative accessibilities of various points relative to Cape Pillar and relative to Hobart.

Illustrations Number 1 and 2 of this chapter give the normal relative accessibility in percents. Illustration number one also shows the integral accessibility in both cubic miles and in landmarks, the figures in the illustrations number 3 , 4 and 5 of this chapter give the integral accessibilities in seamarks.

We still have to deal with two further subjects here and now - with distances shrinking along communications, and with the concept of a range.

THE NOTION OF SHRINKING DISTANCES

This is not a new concept. It has been known for some time that since the introduction of fast mechanized transport, distances have shrunk along communications, and our factor "L" tells us how much they have shrunk. If they have shrunk to half, our factor "L" is 2; if they have shrunk to one fifth, our factor "L" is 5, etc. The concept of the volume of accessibility under the accessibility surface which results, tacitly involves the notion of equivalence of the accessibility from large distant areas of low rel. acc., and of accessibility from small nearby areas of high rel. acc.. It assumes that 100 square miles 2 % accessible each, have the same weight as 4 square miles 50 % accessible each, and this in turn is only acceptable, if the principle of convergence of integral accessibility is adhered to, which we shall deal with presently (see pages 88 to 91). Outside the limits of this principle, distant areas are given undue weight, and the effects of nearby areas of high accessibility is underestimated. Beyond the limits of this principle of convergence of I.A. are all the underlying assumptions in which more accessibility is generated by distance, than destroyed by distance, and in a consequential analysis we always get infinity for the integral accessibility of every point.

THE CONCEPT OF A RANGE

The concept of a range is also not very new. It has been known for a long time that phenomena often cover a certain range. The distance we can travel for recreation on a Saturday afternoon, the ranges of various aircraft types, the distance milk is delivered, the area covered by the firearms of a battleship, or the distances determined by the time and fares people are able and willing to afford for daily travel to work, are some examples. In our study we will reserve the letters "R" and "r" to denote such range. So whenever we will see an "r_6" or "R_3" in our analysis, we will know that a range is involved, no matter how camouflaged its existence or how involved its influence.

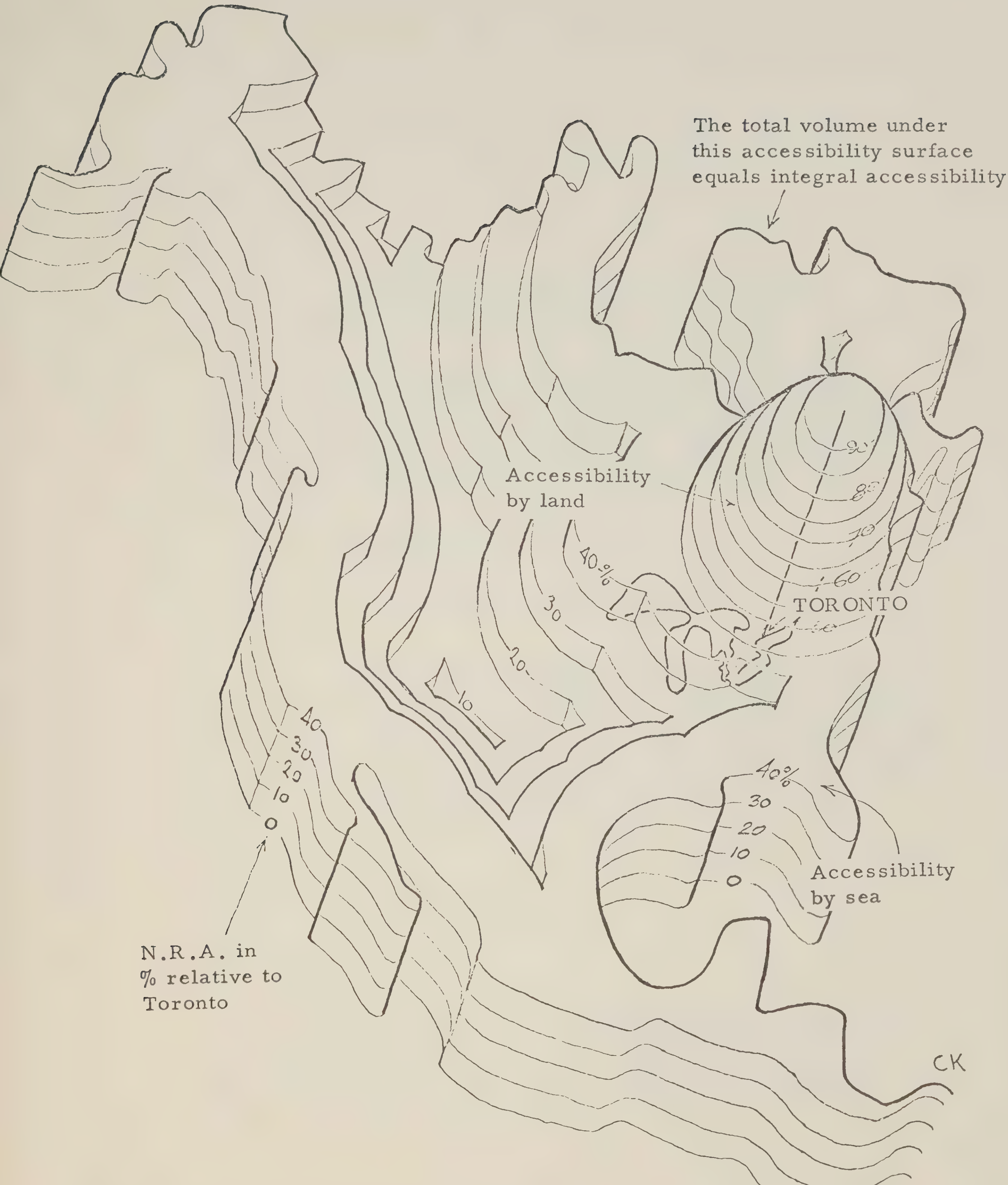
Some of the ranges used here in our Cornwall work are:

0.14 miles (or 600 feet)in survey of non-conforming uses,
0.50 to 1.00 miles, neighborhood accessibilities,
7 and 20 miles with regional accessibilities around Cornwall,
100 and 2,000 miles, medium-range accessibilities of the St. Lawrence Seaway, car traffic accessibilities and the effect of the building of highway 401,
600 and 12,000 miles, Global accessibilities of the St. Lawrence Seaway.

We see, that each set is about six to twelve times larger that the preceding range, and such five sets of ranges can cover our investigations in equal steps, from a smallest, local scale to the largest Global size.

We are now prepared to calculate integral accessibility. We will first express, in cubic miles, the volume under the surface of all relative accessibilities (relative to a point). This will give the integral accessibility (of that point) in cubic miles. Herewith the laborious part of the work is done. (See fig. UP2 - 02).

Under circumstances we will wish to compare patterns of integral accessibility. In these cases it will be usually desirable to have a more absolute unit. We shall then select a measure in seamarks or in landmarks. The volume under the accessibility surface of the minor range can serve as our standard, and we shall divide all the volumes by that measure. We will then say, that a point has an integral accessibility of five landmarks for example, if the volume under its accessibility surface is five times the volume under the accessibility surface of our standard range. The concept of a range is a cornerstone in any investigation into accessibility.


The total volume under this accessibility surface equals integral accessibility
Accessibility by land
90
80
70
60
40%
30
20
10
TORONTO
40
30
20
10
0
N.R.A. in % relative to Toronto
40%
30
20
10
0
Accessibility by sea
CK

NORMAL RELATIVE ACCESSIBILITIES RELATIVE TO TORONTO AFTER THE OPENING OF THE ST. LAWRENCE SEAWAY

Figure UP2 - 02

INTEGRAL ACCESSIBILITY IN 21 STEPS

There are researchers who would like a precise exposition, but in simplest terms, of the principles of investigation into accessibility. These readers can find their joy on the following fifteen pages, the author hopes. Other investigators might perhaps prefer to skip those tedious 21 steps to integral accessibility, and join us on page 84.

FIRST STEP:

We take a map, mark a place with a green cross and call it "Start".

The map we choose must obviously depend on the range we are thinking in. If we are interested in local accessibilities, we will use a local plan. If we want to find the accessibilities in Brazil, we will use a map of Brazil. To investigate the accessibilities of the Australian continent, we might choose a map of the South Pacific. To study the Global accessibilities of the St. Lawrence Seaway, we might use a Globe.

FOOTNOTE:

There might be a little more than meets the eye in the procedure described here. It has been possible to condense other most important mathematical issues involved into the chapter "Principle of Convergence of Integral Accessibility".

So we have taken our map, selected a point, marked the point with a green cross, and called the place our start.

SECOND STEP:

We mark another place on the map and write an arbitrary percentage to it, say 18 per cent. This we will say, is the relative accessibility of the second place, relative to our start.

THIRD STEP:

We mark a further (third) point on the map and observe whether it is more accessible from the start than the second point or less. Say it has turned out to be less accessible, so we have assigned it 6 per cent of relative accessibility. We write this number down at the point.

FOURTH STEP:

We mark another, (fourth) point and do the same, writing down at the point the relative accessibility, say it turns out to be 12 per cent.

FIFTH STEP:

We select at random twenty points on the map and write at each point the relative accessibility relative to our start.

SIXTH STEP:

We select at random any large number of points and write down their accessibility relative to the start.

SEVENTH STEP:

We join all the places of equal relative accessibility, that is all the places with the same number by a green line, so getting a sort of green contour map of equal relative accessibilities relative to the green start.

It is quite possible that these lines of equal relative accessibility will be very closely related to the lines of equal travel time from our green start.

EIGHTH STEP:

We choose a second start and mark it by a red cross on our map.

NINTH STEP:

We select a great number of points, note their relative accessibility relative to our second start, and join all points of equal relative accessibility by red lines. So we get another, red contour map.

TENTH STEP:

We choose a third start, and mark it with a blue cross.

ELEVENTH STEP:

We draw with blue pencil the lines of equal relative accessibility from our blue start.

TWELFTH STEP:

We choose a further start, mark it with a purple cross and draw with purple pencil the lines of equal relative accessibility.

THIRTEENTH STEP:

We mark a yellow start and draw in yellow the lines of equal accessibility.

FOURTEENTH STEP:

We select a great number of starts, mark them each in a different colour and draw the lines of equal relative accessibility to each start in the appropriate colour.

As a result, we now have a number of coloured starts, each one surrounded by coloured contour lines of various shapes and sizes. Lines of different colour will generally overlap, like in actual life, but this should not worry us for the moment.

FIFTEENTH STEP:

We observe again that we have got a number of starts with contour lines of different sizes around them, and we select say the blue start with the blue contour lines as our standard.

SIXTEENTH STEP:

We observe for example the yellow contour lines, and find, that the area enclosed by each yellow contour line is, say twice the area enclosed by the corresponding blue contour line. So we conclude that our yellow start will be more accessible from the surrounding area. Perhaps we will assign 2 marks to the yellow start. That is,we will say the integral accessibility of the yellow start is twice as large as the integral accessibility of the blue start, consequently we will write in black ink the number 2·00 to our yellow start, and the number 1·00 to our blue start.

SEVENTEENTH STEP:

We examine the red contour lines and find that the areas enclosed by each red contour line are 1.6 times the area enclosed by the corresponding blue ones, so we say that the integral accessibility of the red start is 1.6 times our standard, and we write in black ink the number 1.6 to our red start.

EIGHTEENTH STEP:

We compare the green contour lines with our standard and conclude that the integral accessibility of the green start is say 0.6 times the integral accessibility of our blue start. We write in black ink 0.6 to our green start.

NINETEENTH STEP:

We take the purple start and find its integral accessibility to be 2.2 times our standard, and we write in black ink 2.2.

For illustration we have chosen here the area as our criterion, but we could have equally well chosen the number of inhabitants, etc. as mentioned on page 74.

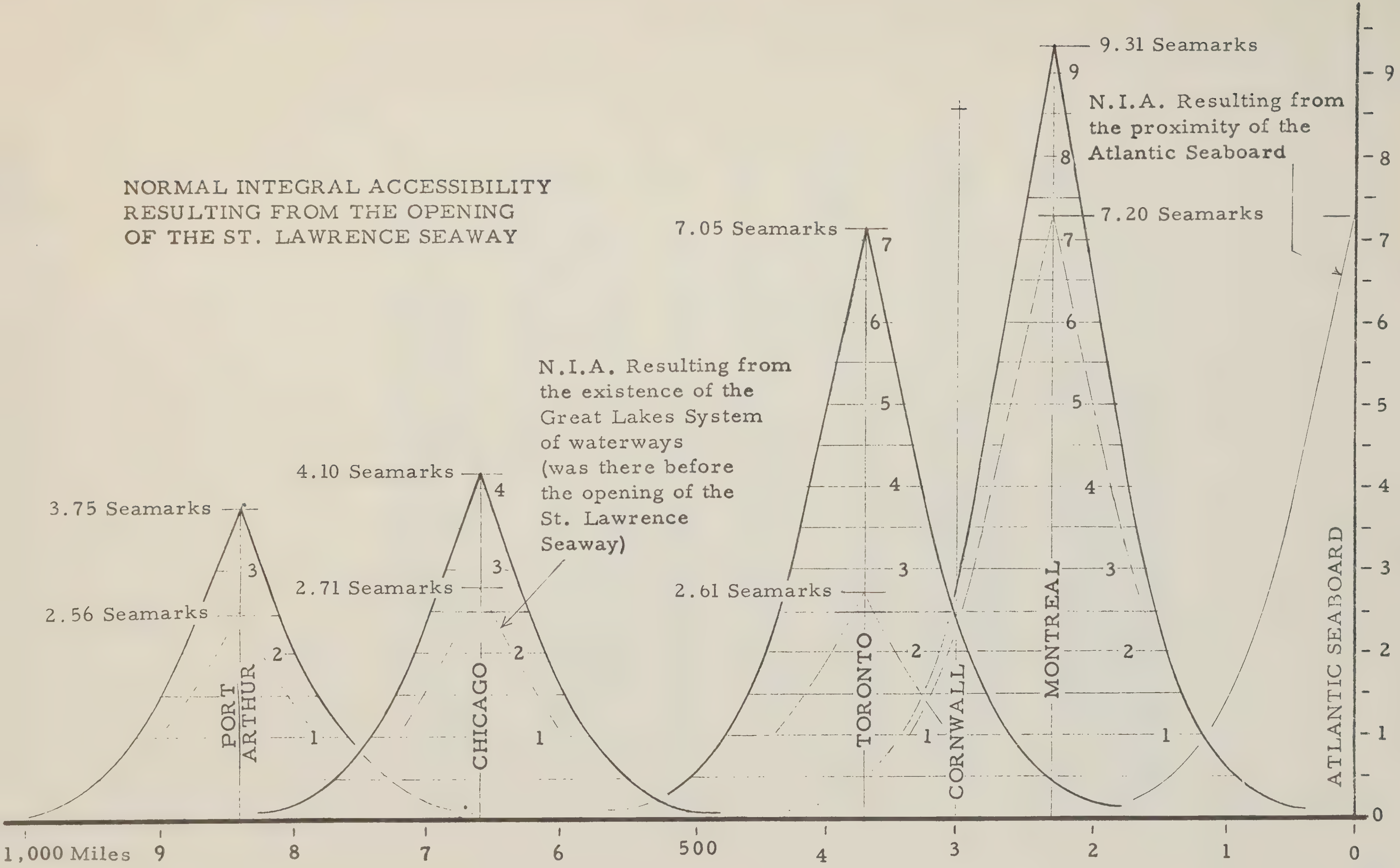
TWENTIETH STEP:

We find the integral accessibility of each one of our starts, and write them in black ink.

TWENTY FIRST STEP:

We join all the places of equal integral accessibility by a black line. We have herewith arrived at a different contour map of our region. We have drawn the map of integral accessibility.

* * * * * * *



NORMAL INTEGRAL ACCESSIBILITY RESULTING FROM THE OPENING OF THE ST. LAWRENCE SEAWAY

Fig. UP2-03

TWO BRIEF WAYS TO INTEGRAL ACCESSIBILITY

There are other ways of arriving at the same result. The following one might be a help to some readers, as the description is short.

1) We have an electronic computer select at random half a million points around the green start, find for each point its relative accessibility, relative to the green start, and add up these relative accessibilities.

2) We have the computer select at random half a million points around the red start and add up their relative accessibilities.

3) We have the procedure repeated for each start, so getting a different total for each start.

4) Finally we join all the starts of the same total and arrive at our contour map of integral accessibility.

To describe these four operations is quick. In actual practice, however, the electronic computer Silliac of the Sydney University gave more exact results in a shorter computing time by a straightforward integration along the line of our 21 steps.

To the mathematician our procedure is nothing new, and he would say that we have simply been determining a scalar point function in finding - by double integration - the volume under a relative accessibility surface.

A mathematician would probably describe the step as follows:

a) STEPS 1-14

We have assigned a relative accessibility surface to each point.

b) STEPS 15-20

We have found by double integration the volume under the accessibility surface, (hence integral accessibility). The result, this volume,the integral accessibility, is a scalar which will be generally different for different points. The integral accessibility is therefore a scalar point function.

c) STEP 21

We have joined all the points of equal integral accessibility, so showing up peaks, depressions, gradients, and other features of integral accessibility.

* * * * * * * * * * * * *

Had this been done for the area around Kuinderbrugg, it would have shown up, that at present the most accessible place in the vicinity is Lyttelgeest. Moreover it would also have suggested the steps necessary to change the situation and make Kuinderbrugg the most accessible place in the surrounding area.

An analysis of this kind carried out for the London Region results in the picture of integral accessibilities shown in figs. UP2.10 and UP2.11, which were submitted in 1959 at the Town Planning Summer School in Southampton.

The integral accessibilities resulting from a few groups of typical transport patterns were analyzed in Sydney, Australia. For lack of space we include here only one example, and we select pattern "B", because it is an illustration of a typical peak generating concentration.

In an age when we are connecting our Globe by millions of Horse Power in transport, a clear-cut concept of accessibility might perhaps even give us an interesting new insight into the reasons which seem to be subconsciously actuating nations, if we observe the movement of populations in the light of integral accessibility.

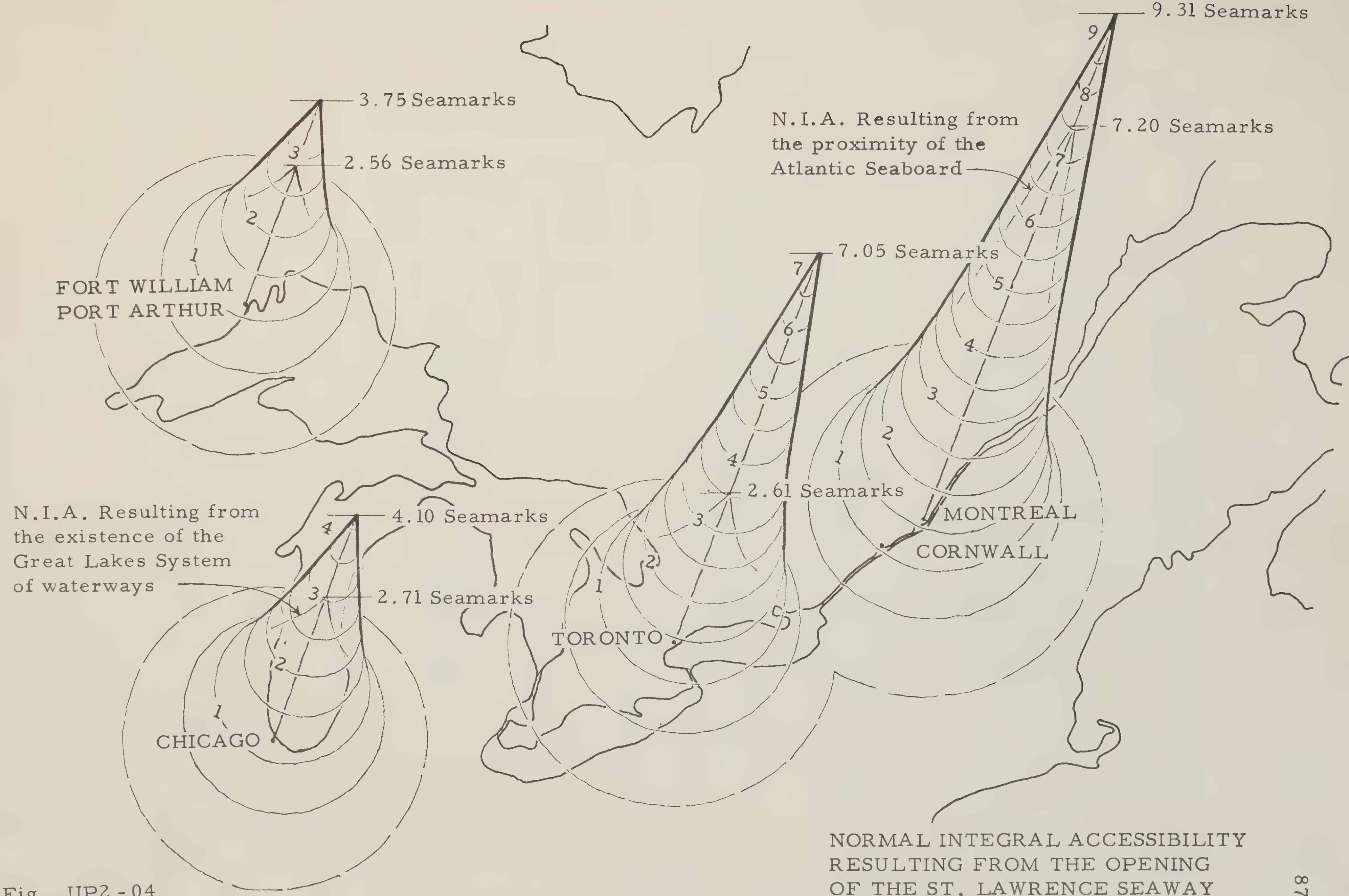

9.31 Seamarks
9
8
7.20 Seamarks
N.I.A. Resulting from the proximity of the Atlantic Seaboard
7
6
5
4
3
2
1
MONTREAL
CORNWALL
7.05 Seamarks
7
6
5
4
2.61 Seamarks
3
2
1
TORONTO
3.75 Seamarks
3
2.56 Seamarks
2
1
FORT WILLIAM
PORT ARTHUR
4.10 Seamarks
4
N.I.A. Resulting from the existence of the Great Lakes System of waterways
3
2.71 Seamarks
2
1
CHICAGO

Fig. UP2-04

NORMAL INTEGRAL ACCESSIBILITY
RESULTING FROM THE OPENING
OF THE ST. LAWRENCE SEAWAY

UP2 - 3

PRINCIPLE OF CONVERGENCE OF INTEGRAL ACCESSIBILITY

"The existence of the limit, the convergence of integral accessibility is one of the cardinal points of our work on accessibility."

THE PRINCIPLE OF CONVERGENCE OF INTEGRAL ACCESSIBILITY

Integral accessibility is always convergent. In other words the sum, the integral, of all the relative accessibilities of a point is limited. That the integral accessibility of no place on this planet is at present (1955) large beyond all bounds is an empirical fact, because experience shows, that even the global integral accessibility of places like the port of New York or the port of London has its limits.

We can therefore set it down as an axiom that the integral accessibility of any point is a convergent function. We can regard it as an axiom that the integral of all the relative accessibilities of a point tends to a limit, and only such functions are to be used as accessibility functions which satisfy this requirement.

To illustrate: Linear and inverse linear proportionality is out. Functions whose first moment relative to the origin is finite are all right. Functions that do not run faster to zero than the inverse square of the distance are not good. Most of the frequency functions of the Pearson system are suitable. The inverse of the figure series on page 67 of the introduction, based as it is on the normal function, will stand this test.

Among the group of suitable functions we will restrict our investigations here to the following three functions of (relative) accessibility:

The ordinary rectangle,

the normal Gaussian Err-function:

$\exp(-r^2)$ of the theory of probability, and

the exponential function:

e^{-r}

Consequently we will speak of crude, normal, and exponential accessibility. We call the first kind of relative accessibility (on the top of figure UP2.05) "crude", because we paint here only black or white, fully accessible or entirely inaccessible. The relative

accessibility of two points is here either 100% or zero. With administrative regulations, like fare limits for weekly tickets, boundaries of customs duties, zoning regulations etc., the situation is often of this sharply delineated type. The relative accessibility is here crudely supposed to be everywhere up to the limit of our range 100%, and zero anywhere beyond the range.

In the normal and in the exponential function the accessibility is falling off much less abruptly, I would say much more naturally. The reader will notice that the relative accessibility in a distance of one-and-half ranges is still about 10% in normal accessibility, and the value is still 10% in a distance of two-and-half times R_0 outside our range in exponential accessibility. This is in accordance with the experience of life, where limitations presented by distances are usually not sharp, but gradual.

The first type of relative accessibilities is therefore a case of sharply defined boundaries, the lowermost variety a case for phenomena with very vague limits. The normal relative accessibility in the middle of the illustration is for our purposes a well balanced case between these two extremes. (Viz. page 91). The integral accessibility of each one of these functions is convergent.

The principle of convergence of integral accessibility can be looked upon as the concept of range expressed in mathematical language. Or more correctly; the concept of a range is one of the things automatically taken care of by the principle of convergence of integral accessibility.

Encircling every start there always exists at least one closed region (range) in which the divergence of the gradient of relative accessibility exists. In other words, unlike gravity, which is not annihilated but only spread over a larger area, or unlike light in emply space, accessibility is destroyed by distance and there is in being around every point a closed belt in-(or a closed curve on-) which:

$$\text{div grad (relative accessibility)} > 0$$

The existence of the limit, the convergence of integral accessibility is indeed one of the cardinal points of our work on accessibility.

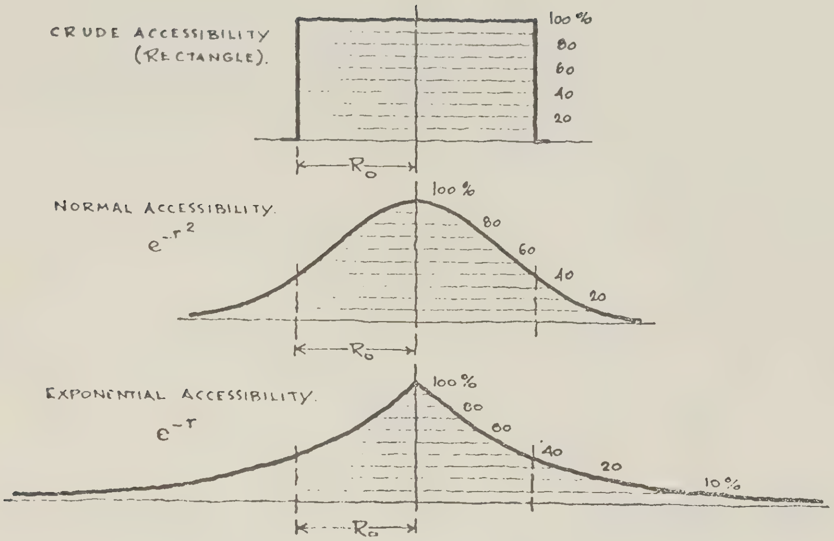

CRUDE ACCESSIBILITY
(RECTANGLE).
100 %
80
60
40
20
R_0
NORMAL ACCESSIBILITY.
e^{-r^2}
100 %
80
60
40
20
R_0
EXPONENTIAL ACCESSIBILITY.
e^{-r}
100 %
80
60
40
20
10 %
R_0

Figure UP2 - 05

The principle of convergence of integral accessibility, the law to which relative accessibilities have to conform, can be regarded as the concept of a range expressed in mathematical language. This illustration shows three ways of expressing relative accessibility within the framework of that rule:

1) The ordinary rectangle,
2) the normal Gaussian Err-function $[e]^{-r^2}$
   of the Theory of Probability, and
3) the Exponential function.

The first is a case of sharply defined boundaries, the last one a case for phenomena with very vague limits; the normal accessibility function is a case "in between". The integral accessibility of each of these three functions is convergent. The existence of the limit, the convergence of integral accessibility, is indeed one of the cardinal points of our work on accessibility.

UP2 - 4

NORMAL RELATIVE ACCESSIBILITY

A few remarks to a theory of
normal relative accessibility

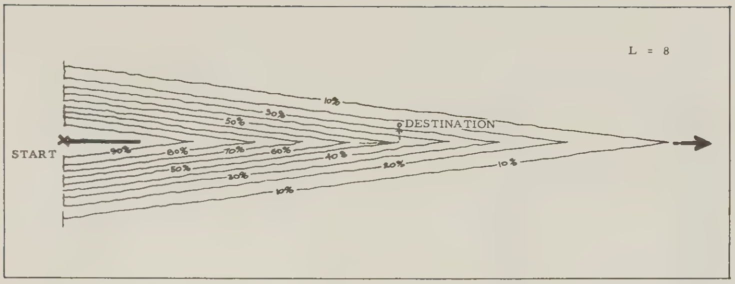

L = 8
10%
30%
50%
DESTINATION
START
90%
80%
70%
60%
40%
20%
10%
50%
30%
10%

Figure UP2 - 06

Accessibility purely on a time basis:

$$\text{rel. accessibility} = 100\, e^{-(b + \frac{c}{L})^2}$$

It is however not the most general case, because not always 3 hours of travel plus one hour of walk, equals 2 hours of travel plus 2 hours of walk. The equation employed for expressing accessibilities then has to take account of this fact.

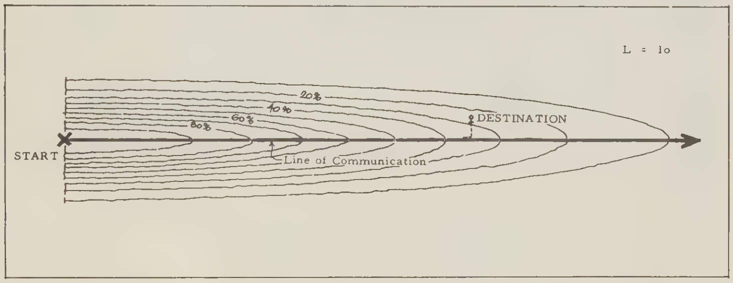

L = 10
20%
40%
60%
80%
DESTINATION
START
Line of Communication

Figure UP2 - 07

An accessibility surface with possibly the most general application is:

$$\text{N.R.A.} = 100\, e^{-\left[\left(\frac{c}{Lr_o}\right)^2 + \left(\frac{b}{r_o}\right)^2\right]}$$

Such accessibility function is the one underlying the chapter Accessibilities of Transport Patterns. The case illustrated shows in per cents the normal relative accessibilities, relative to a start on a line of communication.

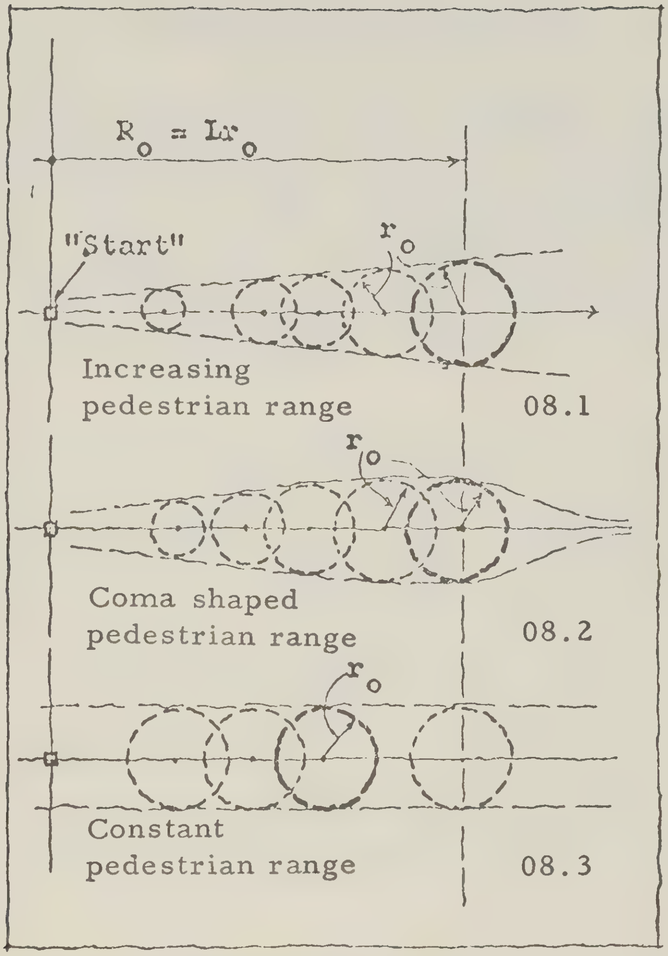

$R_o = Lr_o$
"Start"
r_o
Increasing
pedestrian range
08.1
r_o
Coma shaped
pedestrian range
08.2
r_o
Constant
pedestrian range
08.3

Figure UP2 - 08

Combination of two ranges along a line of communication with shrinkage of distances "L", (see pages 73 to 76, and 92 to 104).

SPECIFYING THE RANGE

The science fiction writer Arthur C. Clarke has given us a vivid picture of the moving highways of the future,*) and "the idea is so beautiful, and such an improvement on conventional schemes, that it will be a great pity if it turns out totally impossible". Instead of a road you have a conveyor belt. The ideal conveyor belt would be one that has a smoothly increasing speed-gradient from edge to the centre, so that there are no sudden jumps in velocity. The flow of a river exhibits this kind of behaviour.

Perhaps local electric, magnetic or other fields might produce an anisotropic effect on a fairly thin layer of a powdery or liquid substance "X" supported on a fixed solid base in which the necessary polarising fields are generated. These fields give "X" its rigidity in the vertical direction and also impart the desired velocity gradient across the strip. You can step on the edge with perfect confidence because it is almost stationary, but if you walk towards the centre of the belt, you will experience a smooth and steady increase in speed, until you reach the Express section." At the end of the road the flow is reversed via roundabout. Or the field could be switched off, substance 'X' would revert to a normal, well behaved liquid or powder and could be pumped back to the beginning of the circuit through pipelines. What would be the normal relative accessibilities around such conveyor belt?

We have to define here the normal relative accessibility of two points which are both near a line of communication. To get from our start to our destination we are to use in succession two (or more) means of transport. Consider the sequence: pedestrian walk from a start to the conveyor belt, followed by "c" miles of travel on the moving highway, finishing by a second walk from conveyor belt to destination. We are dealing consequently on occasions, with a repeated combination of two (or more) ranges.

Footnote: *)

See Arthur C. Clarke:

"Profiles of the Future", London 1962, pages 36 and 37

We shall have to consider three ways of specifying a range along a communication, two extremes and a middle course between the two antipodes.

First extreme, a specification of a range on a time basis, an extreme because the minor range is decreasing in this specification,

Second, the opposite extreme, in which the minor range is slightly increasing with the distance, and

Third, a compromise specification, with the minor range constant along the line of transport.

TIME BASIS (DECREASING PEDESTRIAN RANGE)

To start with, let us assume we are on virgin ground. We stand in the middle of the Australian bush. Endless grassy plain in all directions. It is a warm sunny autumn afternoon, the groups of silvery gum trees shining grey at intervals as far as the eye can behold. Within an hour you can walk 3 miles in any direction. What can we reach within an hour? What is the shape and size of our (one hour) range? The area accessible is now of course a euclidean circle with a radius of 3 miles.

Now let us imagine, such conveyor belt 2,500 miles long, running east-west has been established through our point 'A' overnight by a stroke of magic. The middle section is moving at a speed of 45 miles per hour. Today, along the conveyor belt, we can reach with the same amount of trouble 15 times as far as yesterday, Everywhere off the conveyor belt we still can cover in an hour 3 miles toward any point of the compass rose. Distances have shrunk as a result to 1/15 in the east-west direction along the communication. How do we get, in per cents, the relative accessibility of any two points, say from 'A' to 'B'?

To ask what is accessible from 'A' has no meaning. All we can answer is, that today, in the 20th century, any point on our globe (and many a place beyond) is accessible from 'A'. It is an entirely different matter if we specify a range, say by asking what is accessible from 'A' within an hour. This question can be answered.

So first we have to specify a range and there is now the possibility of defining relative accessibility strictly as a function of the time involved in reaching "B" from "A". Let us imagine we are investigating what is accessible within an hour, what is inaccessible within an hour, what is more accessible within that period and what is less. That means we have specified our accessibilities by a range on the time basis. The lines of equal relative accessibility would here, of course, be straight lines, running at a slight angle

$$\mathrm{tg}\,\alpha = r_o / R_o = 1 / L = 1/15 ,$$

to the centre line of the east-west communication (see figure UP2.06). This is one extreme of the possibilities of definition.

The formation of the inverse, within the framework of the principle of convergence of integral accessibility, is now comparatively straight forward, as we are dealing with one range only, and the

$$\text{rel. acc.} = \exp(-t^2) ,$$

(where t is the time of travel in hours).

Now it has been pointed out in the thirties by Blum, (O. Blum: Städtebau, page 191, Julius Springer, Berlin 1937), that the pedestrian range is for a given trip increasing with the length of the journey. It follows that travel time and walking time are not necessarily additive. Ten minutes walking plus twenty minutes travel by tube is not necessarily equal to thirty-five minutes walk plus fifteen minutes travel. Does this appear paradox to someone? If we accept the proposition that the pedestrian range should be increasing with the length of the journey, we get under circumstances the answer that the relative accessibility of point "B" from "A" is larger than the relative accessbility of "A" from "B" in the opposite trip. We need not view this with concern. In fact we find such situations often in everyday life. A windward island in the Caribean is by yacht less accessible than a downwind harbour. The Peak of Ben Nevis is less accessible from a point on the Loch, than the relative accessibility of the very same two points down hill.

INCREASING PEDESTRIAN RANGE

Blum is tacitly assuming a linear proportionality between the length of the trip and the pedestrian range. The relationship of the two ranges which follows is shown in fig. UP2.08.1. The resulting normal relative accessibility of two points which are both situated on a tube station "c" miles apart would then be:

$$\text{rel. acc.} = 100\, e^{-\left[\frac{c}{Lr_o}\right]^2}$$

and the relative accessibility of a destination which is to be reached by a "c" miles tube trip plus a walk of "b" miles at the end of the journey would then be given by:

$$\text{rel. acc.} = 100\, e^{-\left[\left(\frac{c}{Lr_o}\right)^2 + \left(\frac{b}{c.\,\mathrm{tg}\,\alpha}\right)^2\right]}$$

In practice you would perhaps avoid a singularity, by not choosing a zero pedestrian range in the start:

$$\text{rel. acc.} = 100\, e^{-\left[\left(\frac{c}{R_o}\right)^2 + \left(\frac{b}{r_o + c/L}\right)^2\right]}$$

The lines of equal relative accessibility from a point on the line of communication resulting on the above basis, are shown in fig. 31, page 172 of the main report.

Objections might be raised against the linear correlation. It can be said that the pedestrian range is probably increasing up to the travel distance Lr_o, and decreasing thereafter, as shown in figure 08.2. The differences in integral accessibility which result, are however again small. The author has found in practice, that the normal integral accessibility of existing metropolitan transport patterns based on figure 08.3, do not differ enough from those on another basis to warrant a pursuit of two or more different sets at this stage.

The figures are also further removed from those obtained solely on a time basis, we have approached the other extreme in the group of possible definitions of relative accessibility.

MINOR RANGE CONSTANT

If we wish one, single value to represent the most general case, then the definition set forth in table 75, (page 102), is the one we are after. In an investigation involving two ranges, a longer range along a line of communication and a shorter range everywhere else, off the communication, we can proceed as follows:

We keep both ranges constant. The small range is 'r_n', the large range is $R_n = Lr_n$.

Expression for the N.R.A. of two points:

75.1 Start "a" miles away from line of communication, destination on line of communication.

$$\text{N.R.A.} = 100\, e^{-\left(\frac{a}{r_n}\right)^2}$$

75.2 Start on the line of communication, destination "b" miles away, off communication:

$$\text{N.R.A.} = 100\, e^{-\left(\frac{b}{r_n}\right)^2}$$

75.3 Start and finish both on line of communication "c" miles apart:

$$\text{N.R.A.} = 100\, e^{-\left(\frac{c}{Lr_n}\right)^2}$$

These are the simpler situations, as there is really a single range involved in each case. The reader will recognize the repetition of the above terms in the exponents of the following expressions for a combination of ranges:

75.4 Journey from start "A" to destination "B" consists of "a" miles to reach the transport line, followed by "c" miles along the line of communication:

$$\text{N.R.A.} = 100\, e^{-\left[\left(\frac{a}{r_n}\right)^2 + \left(\frac{c}{Lr_n}\right)^2\right]}$$

75.5 Start on the line of communication, to reach destination we travel "c" miles along transport line and finish by reaching destination "b" miles away from this line of communication:

$$\text{N.R.A.} = 100\, e^{-\left[\left(\frac{c}{Lr_n}\right)^2 + \left(\frac{b}{r_n}\right)^2\right]}$$

75.6 Start is "a" miles away from communication, destination is "b" miles away from communication, line of communication is being used for "c" miles:

$$\text{N. R. A.} = 100\, e^{-\left[\left(\frac{a+b}{r_n}\right)^2 + \left(\frac{c}{Lr_n}\right)^2\right]}$$

The reader might now wish for a graphic representation of the above equations, and the illustrations UP2.02 and UP2.07, or the lines of normal relative accessibility of Cornwall, Morrisburg or Bonville in the Regional Plan can serve as examples.

Let us examine the accessibilities established by shipping on a world-wide scale on our globe:

R_s = 12,000 miles,
r_s = 600 miles, and consequently
L = 20 = the shrinkage of distances,

that means, the range of land transport is again assumed constand, 600 miles, independent of the length of the sea journey.

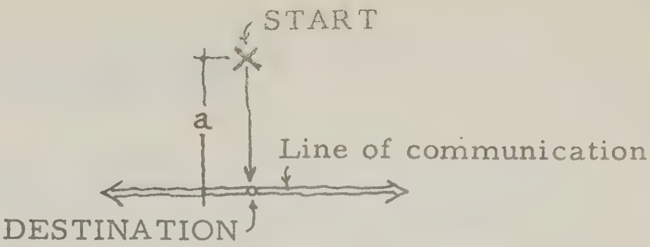
The relative accessibility of any two places of this sea-encircled planet of ours, is then given by:

$$N.R.A. = 100\, e^{-\left[\left(\frac{a+b}{600}\right)^2 + \left(\frac{c}{12,000}\right)^2 \right]}$$

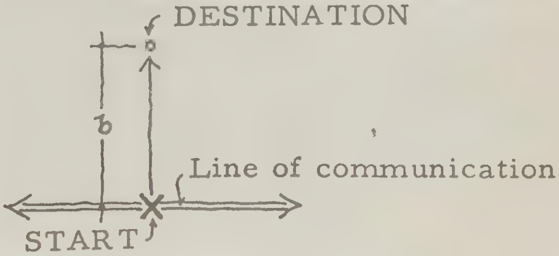
and the accessibilities based on this accessibility function, resulting from the opening of the St. Lawrence Seaway, are shown in figure UP2.09 of this chapter.

The integral accessibilities resulting from an integration of this function on a global scale can be seen in figure 009 and 007 of the main report. The high integral accessibility of the coast of continents is shown there forming peaks. This is because today's feeder services to shipping are focused according to patterns A, B, C, D, or E, (see pages 138 to 212 of the main report). Should the hovercraft become the accepted means of ocean travel of the future, the high level of integral accessibility would spread along the whole coast, because the craft can land anywhere. So the peaks would expand sideways into a continuous ridge, and the picture of integral accessibility would go over from fig. 007-2, of the accessibilities of today, into the accessibilities of fig. 007-1, of the future. Experience will have to let us find the ranges R_h and r_h of the hovercraft.

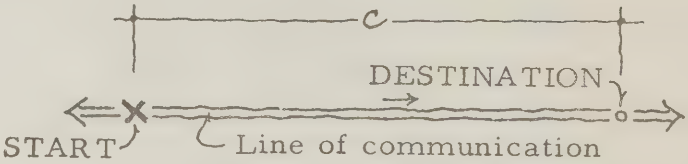
$$\text{N.R.A.} = 100\, e^{-\left(\frac{a}{r_n}\right)^2}$$


START
a
Line of communication
DESTINATION

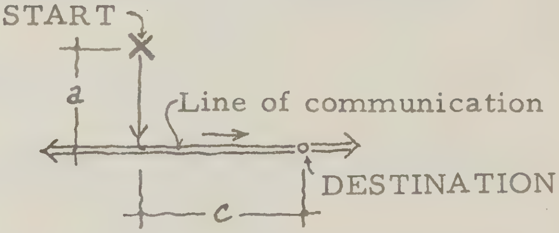
$$\text{N.R.A.} = 100\, e^{-\left(\frac{b}{r_n}\right)^2}$$


DESTINATION
b
Line of communication
START

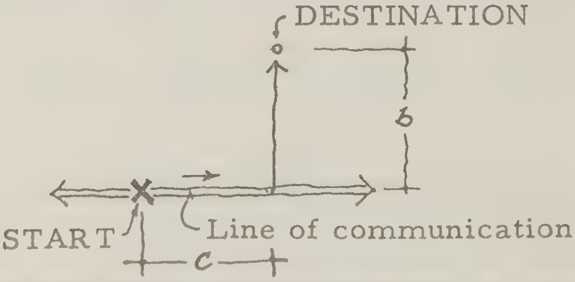
$$\text{N.R.A.} = 100\, e^{-\left(\frac{c}{Lr_n}\right)^2}$$


c
DESTINATION
START
Line of communication

$$\text{N.R.A.} = 100\, e^{-\left[\left(\frac{a}{r_n}\right)^2+\left(\frac{c}{Lr_n}\right)^2\right]}$$


START
a
Line of communication
DESTINATION
c

$$\text{N.R.A.} = 100\, e^{-\left[\left(\frac{c}{Lr_n}\right)^2+\left(\frac{b}{r_n}\right)^2\right]}$$


DESTINATION
b
START
Line of communication
c

$$\text{N. R. A.} = 100\, e^{-\left[\left(\frac{a+b}{r_n}\right)^2+\left(\frac{c}{Lr_n}\right)^2\right]}$$

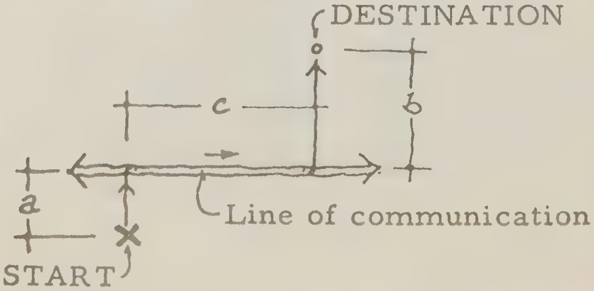

DESTINATION
c
b
a
Line of communication
START

Table 75

A FEW FINAL REMARKS

In the 1950's, the present writer put down the preceding few of those considerations which made him select the use of normal relative accessibility so often. He has put these thoughts on paper under protest, because this manner is not the only way of defining relative accessibilities. Any method which will satisfy the principle of convergence of integral accessibility is suitable. In fact planning has to use not only one relative accessibility function alone. There is an analogy here between probability calculations and and accessibility. The theory of probability is also working with a whole set of functions, not with the normal function only.

One very suitable function the writer has for the time being rejected in favour of the normal Gaussian Err-function is:

$$\text{rel.acc.} = e^{-r\left[1+\frac{2}{1+r^2}\right]}$$

The reasons here were purely practical. If we employ the normal Err-function, we make use at once of a wealth of computation contained in tables publishing this function for complex, as well as for ordinary argument.

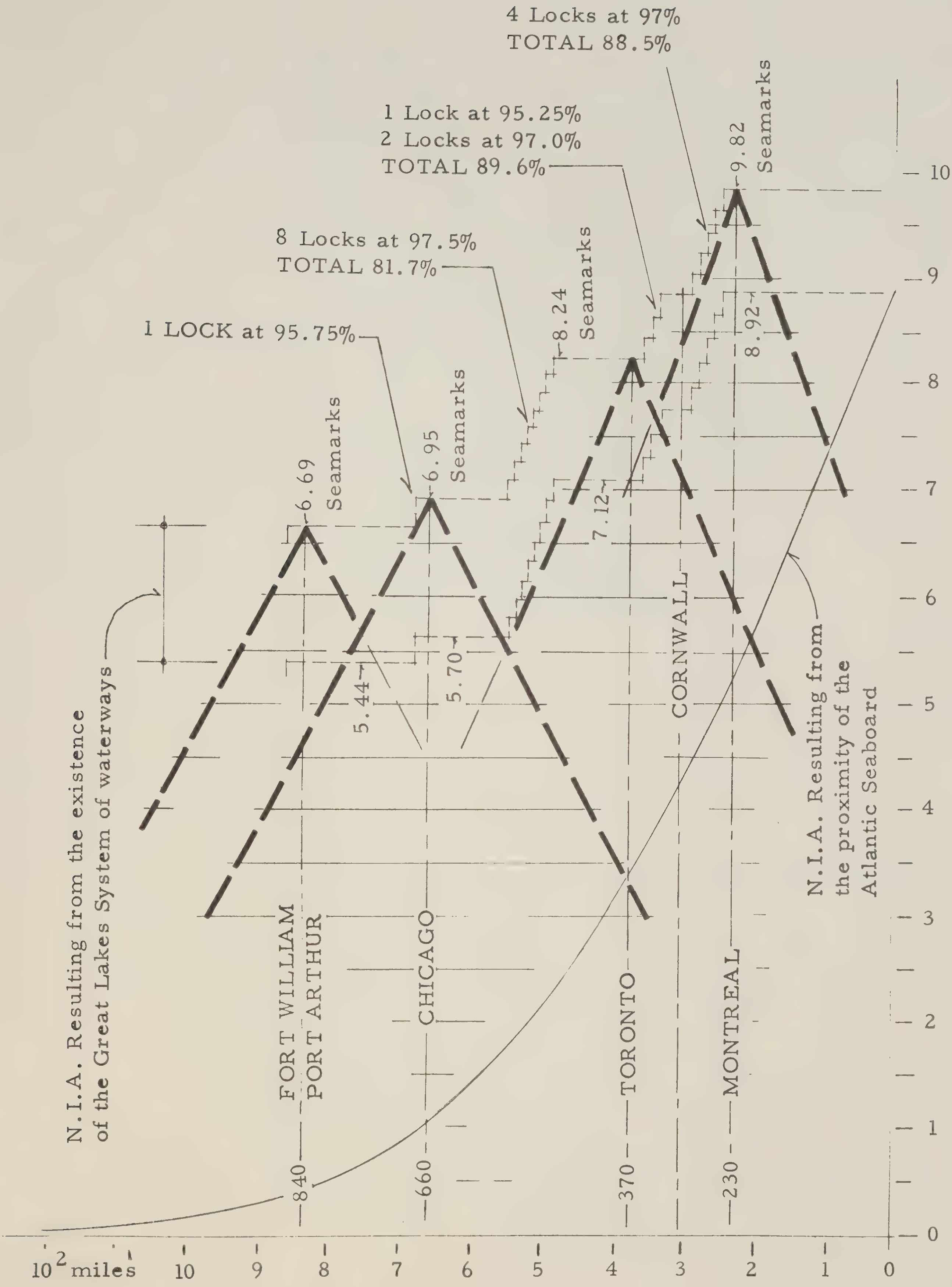
Some salient features of this function:

1) In those most critical places, at the distance equal to the range 'r_o' the function is identical with the Gaussian Err-function.

2) At the origin it is more flat topped than the normal Err-function.

3) Beyond the range, towards infinity it goes over into the exponential function e^{-r}.

Fortunately the choice of the type of relative accessibility function is not critical, so long as we stick to the principle of convergence of integral accessibility. As expostulated, we have three main components determining the level of accessibility: the shrinkage of distances 'L', the range 'R_n' and the accessibility function (see pages 71 to 76, and 88 to 91). Of these three elements the relative accessibility function is the least influential factor. Be this our consolation. It makes a minor difference only to the result, which kind of relative accessibility function we select, while conforming to the principle of convergence of integral accessibility.



NORMAL INTEGRAL ACCESSIBILITY AFTER
THE OPENING OF THE ST. LAWRENCE SEAWAY

UP2 - 09

UP2 - 5

ACCESSIBILITIES
IN GR. BRITAIN

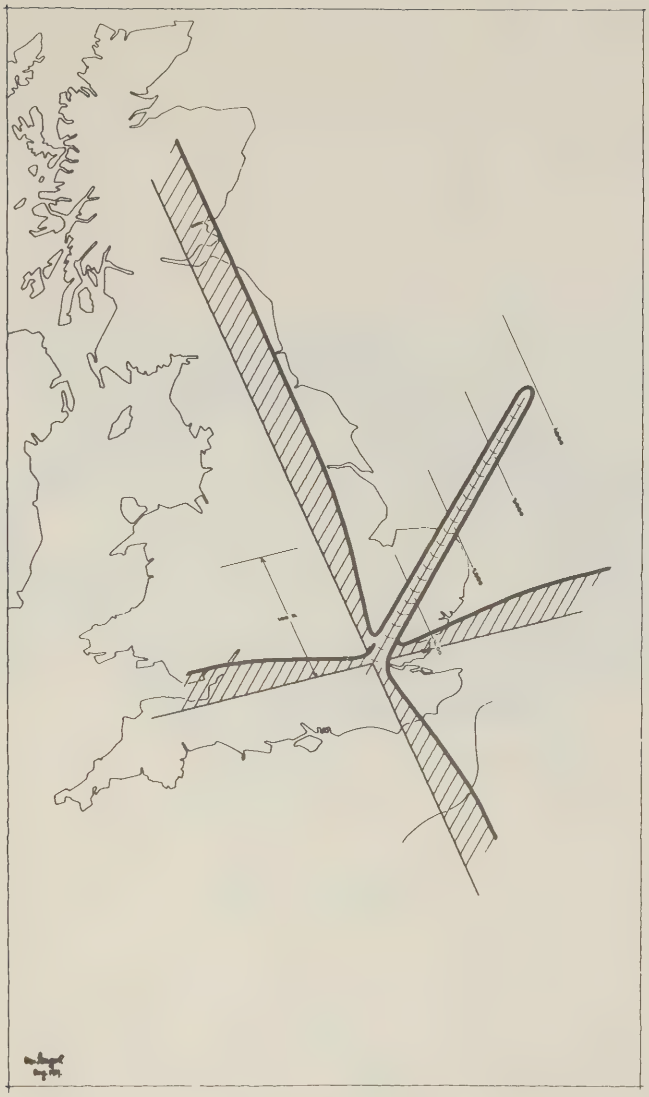


Fig. UP2 - 10

We have here a simplified picture of the main features of the integral accessibility of the southern part of the United Kingdom. (Page 108).

In an east - west section the huge integral accessibility of the City of London falls off to very low values just outside the centre, and from there westward the accessibility is rising again, to reach a "normal" value just before Somerset and the west coast.

In a north - south section the areas around Northumberland and Yorkshire are about normally accessible from the rest of Britain. From about Nottingham southward the accessibility starts to fall off, first slowly, later with a steeper gradient, but just before we reach the centre of London the integral accessibility suddenly changes the sign of her gradient, and shoots up to the huge peak in the City of London.

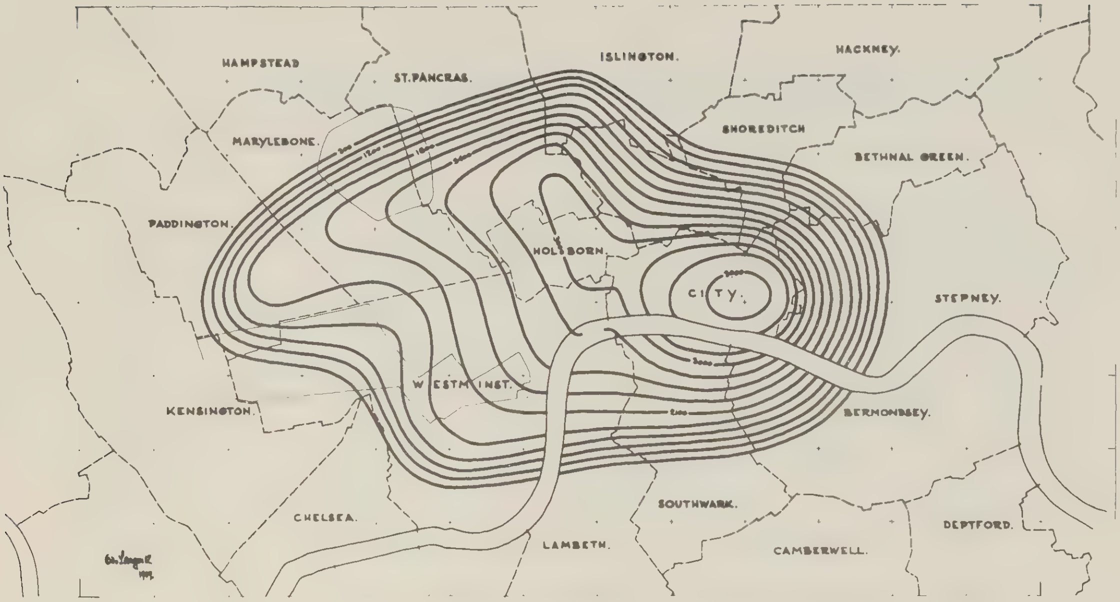

HAMPSTEAD
ST. PANCRAS.
ISLINGTON.
HACKNEY.
MARYLEBONE.
SHOREDITCH
BETHNAL GREEN.
PADDINGTON.
HOLBORN.
CITY.
STEPNEY.
WESTMINST.
KENSINGTON.
BERMONDSEY.
SOUTHWARK.
CHELSEA.
LAMBETH.
CAMBERWELL.
DEPTFORD.

Fig. UP2 - 11

Joining all places of equal integral accessibility in our twenty-first step (see pages 82 and 85,) we arrive at an important contour map of our region. We have drawn the map of integral accessibility.

The above figure shows a plan, as it were, a detail of the contour lines of the peak of figure two. We see here the shape and the precise position of our column of highest accessibility in Southern Britain. (page 109).

ACCESSIBILITY IN GREAT BRITAIN

Our Globe has become highly interconnected by modern mechanized transport. The areas of our world have become very accessible from each other. To speak of shrinking distances has become a platitude. Yet a crucial point is usually not appreciated. It is often not fully understood, that this increase in accessibility was by no means equal everywhere. For example, the centre of London has been made by mechanized transport more accessible from the rest of Britain than any other point of the United Kingdom. The consequent tendency, the drift towards the centre of London, is known.

On our fig. UP2 - 10 we have plotted in two kind of cross sections how accessible various points of England are from the rest of the world . The vertical scale, the height, represents how interconnected by mechanized transport various points of this country are, how interconnected by mechanized transport with the surrounding country and the world at large. We call this the integral accessibility. We have here in figure ten a simplified picture of the main features of the integral accessibility of the southern part of the United Kingdom.

We say elsewhere how these values have been arrived at. For the present it is sufficient to observe that the integral accessibilities in the London Region show a huge peak at the centre, surrounded by a strictly concentrating ring of low accessibility. It has extremely important regional consequences, that some of the most inaccessible places of the metropolitan region are in the nearest vicinity of the core, immediately surrounding the centre. The highly accessible centre is surrounded by an inaccessible ring.

In fig.UP2 - 11 we see a plan, as it were, a detail of the contour lines of the peak of figure one. We see the precise position of our column of highest accessibility in southern Britain.

We can see that the column is not really circular, and if we observe the height of our column more closely, we see that the highest peak is in the eastern part of the City. There our accessibility is "very hot". The temperature of our Lady Accessibility has been raised here by engine driven transport to 3900 units of integral accessibility.

The western part of the column is much wider. The contour lines of equal integral accessibility form here a sort of plateau between Holborn and Westminster. The accessibility is here still very high, but not quite as high as in the City. Compared with our 3900 marks for the peak in the City, our West End plateau would get 3000 units.

Once we have found the integral accessibility of all places of a region and plotted them on a vertical scale as in figure 1o, 11, and 12, we can observe the influence of this accessibility rather clearly.

The above values are based on a two-hour range and are not unimportant. Why do I not want to live in an excellent place like Coventry or Welwyn? Because Britain is so inaccessible from Coventry or Welwyn. Why do I want to live in such a disagreeable place as London? Because Britain is so extremely accessible from London.

The simple upshot of figure 12.1 is, that if everybody were travelling by car only, we need not have any cities at all, every point of Britain would be equally accessible from the rest of the United Kingdom as any other point.

If the car were our only means of transport, there would be no advantage of having any cities, at least not as far as accessibility is concerned. An even sprawl of everything spread evenly all over the country would do, because the integral accessibility for car traffic is constant at eleven cu. miles everywhere.

These 11 cu. miles are an example in which the integral accessibility is determined by capacity. The low permeability of urban areas for car traffic is setting this limit.

To be exact, the integral accessibility for the private car varies within narrow limits around eleven cu. miles, and fig. UP2 - 13 shows this situation near an Outer London tube station.

As practical experience in other countries teaches, we can raise this integral accessibility with great efforts and large expenses by numerous expressways to say 18 cubic miles . By then we have just about destroyed the urban character of the vicinity. We have removed the city, and replaced it by a system of throughfares for car traffic. And as post mortem investigation shows, the integral accessibility would still have been everywhere about nine to eleven cu. miles if we had done nothing about it.

So the integral accessibility for car traffic has no distinct peaks at all, and if the intensity of development is influenced by integral accessibility, then exclusive car transport would bring about a development corresponding to the top left hand picture 12.1, no peaks, no depressions, just an even spread.

Similarly, if development were proportional to accessibility, and air transport would be our only means of transport, then the development of Britain would become similar to fig.12.2, on the right hand top. Everything would flow into the huge peak at London, or into the large peak at Glasgow, also a little would concentrate in those three dozen small peaks scattered over the country, whereas elsewhere, away from these peaks - well there our present day air transport does not give you much integral accessibility.

If all transport but shipping were on strike, then the integral accessibilities of the United Kingdom would take the shape of the lower left hand figure 12.3, and if we had no other transport but railways, then we would get a central area of high intensity, a sharp, high peak of accessibility where our railways converge, and accessibility would radiate like knotty fingers along the railways out of these centres.

If development would then conform to accessibility, Britain would move within two or three generations toward the forms of figure 12.4. We would have huge sharp peaks, with depressions nearby, or without, as will be investigated in the following chapter on patterns of accessibility.

An expert who arrived in Britain in 1959 or 1960, with all the transport strikes of those years was fortunate. He could observe the various components which make places accessible put out of action, one at a time. He had a chance of studying the practical effect of eliminating railways, bus transport shipping etc., one by one as in a controlled experiment and he was in a position to see how much of our life follows on patterns of accessibility.

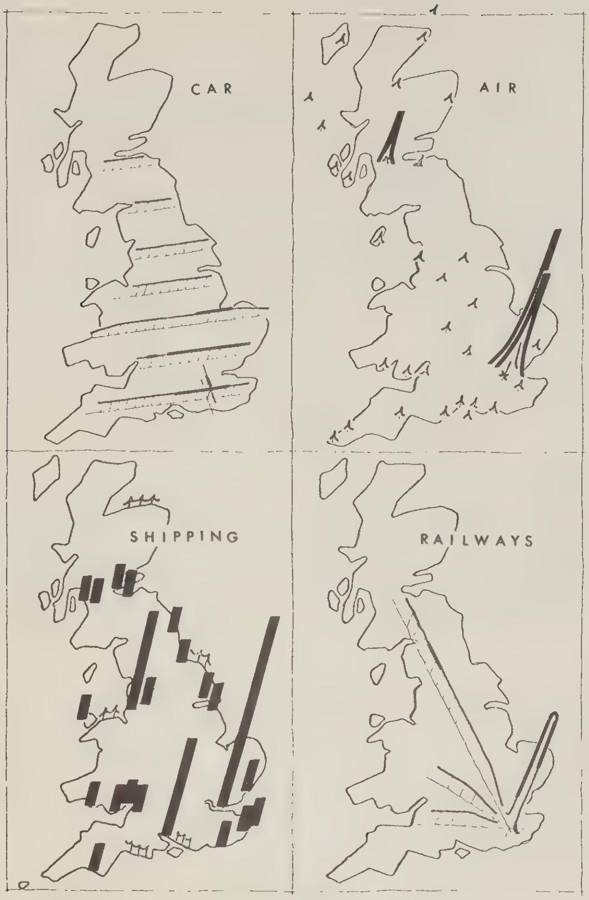


Fig. UP2 - 12

... " If everybody were travelling by car only, as in fig. 12.1, there would be no advantage of having any cities" ... (page 110).

If development were proportional to accessibility, and air transport would be our only means of transport, then Britain would approach the shapes of figure 12.2. Everything would flow into the huge peak at London and Glasgow, and the development of Britain would become within two or three generations similar to the figure on the right hand top.

If all transport but shipping were on strike, then the integral accessibilities of the United Kingdom would take the shapes of the lower left hand figure 12.3.

If we had no other means of transport but railways, then we would get central areas as in figure 12.4. We would always have an area of high intensity, a sharp, high peak of accessibility where our railways converge, with regional depressions or without, as is investigated in the chapter Metropolitan Transport Patterns.

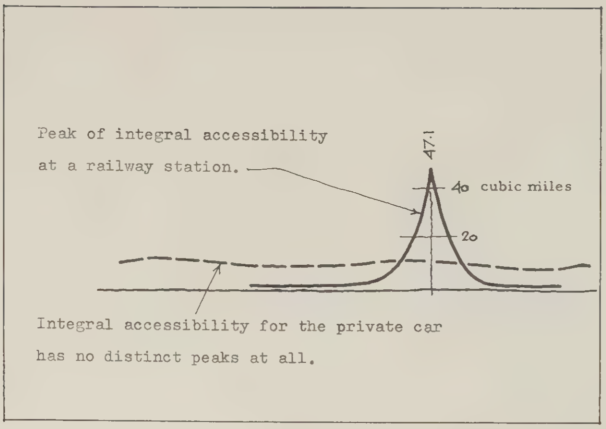


Fig. UP2 - 13

The peak in this figure has nothing to do with car traffic, it serves as a yardstick. This peak, portraying the integral accessibilities near an outer London Tube station, serves as a background against which to judge how constant the values are, of integral accessibility resulting from car traffic.

Two factors appear on the scene to make for the even integral accessibility by private car:
First the simple fact, that by car you can travel more or less with the same ease in any direction, so distances have shrunk almost evenly everywhere in all directions, resulting in about the same integral accessibility for every point,
second, the low permeability of urban areas to car traffic, is setting a limit at about eleven cubic miles.

With car traffic not distance is the factor, limiting integral accessibility of a point via relative accessibilities, but the permeability of urban areas, which allows only a certain amount to permeate from the surrounding region to any place. How accessible a place is from the region around it, is determined by how much can penetrate through urban (and rural) areas.

If a place were by car more than 11 cu. miles accessible from the countryside around it, not everyone could get there by car, but only so many, as would leave the point so accessible from the surrounding region, as the point which is made eleven cubic miles accessible by say bus or tram.

Owing to the fact, that by private car you can travel with just about the same ease in any direction, the integral accessibility for car traffic is everywhere about equal. Every point is by car about equally accessible from the world around it as any other point. Owing to the low permeability to car traffic, of urban areas, the height of this integral accessibility is more or less fixed at eleven cubic miles.

UP2 - 6

METROPOLITAN TRANSPORT PATTERNS

(Including extracts from
Accessibility and Employment,
and Distribution of Populations.

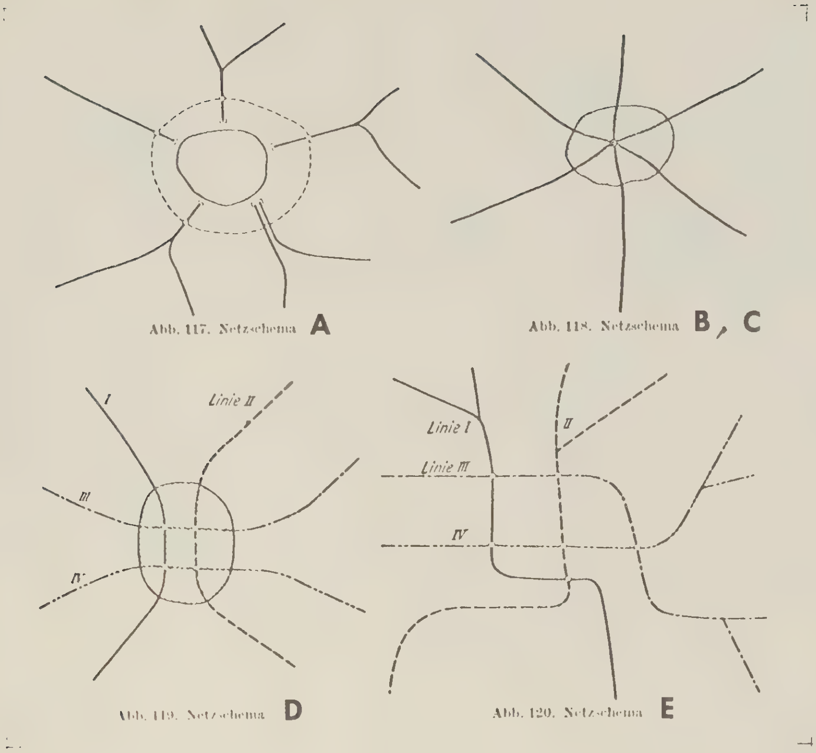


Abb. 117. Netzschema A
Abb. 118. Netzschema B, C
I
Linie II
III
IV
Abb. 119. Netzschema D
Linie I
II
Linie III
IV
Abb. 120. Netzschema E

Fig. UP2 - 14

Transport patterns have been established for metropolitan regions, and these are going to concern us here. The patterns can be divided into five types.

The regional accessibilities are very different if we terminate all transport lines at the centre, and very different if we carry our communications through. Pattern 'B' and pattern 'C' appear therefore similar only until we start looking for accessibility.

Pattern 'C' is the case where all the communications are focused on to one centre but, and this is important, not terminating there. Pattern 'C' is the alternative of focusing, in which all the lines of transport are continuing clearly through the centre to the other side of the metropolitan region.

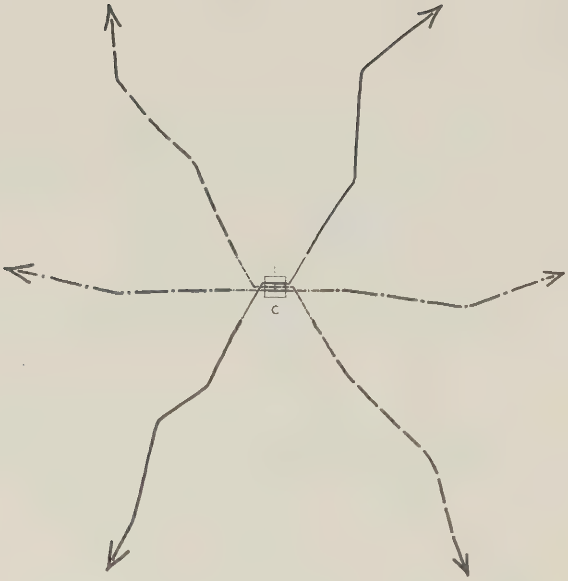


Fig. UP2 - 15

Wrong is the overcentralization in pattern 'B', with the "invisible , sharply concentrating ring " (p. 121). By contrast in pattern 'C' there is no depression of integral accessibility around the centre.

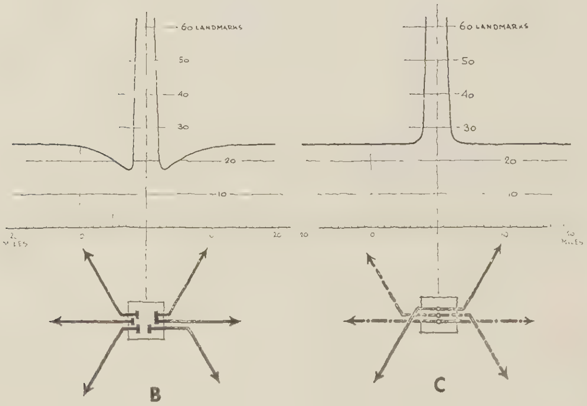
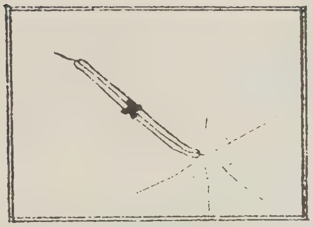
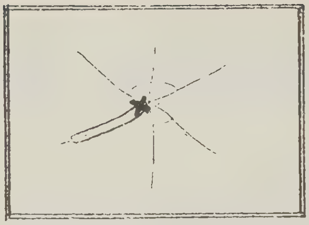
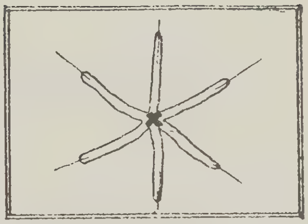

60 LANDMARKS
50
40
30
20
10
MILES
0
20
60 LANDMARKS
50
40
30
20
10
20
0
10
MILES
B
C

Fig. UP2 - 16


UP2 - 17.1


UP2 - 17.2


UP2 - 17.3

" ... The essence of the situation can be understood, if we observe, that a businessman 30 miles outside such metropolis has a choice of travel without interruption to anywhere within 60 miles (30 miles toward the centre and 30 miles outward) , a man 2 miles near the centre has his choice limited to 32 miles, (30 miles outward, but only 2 miles inward) , and a businessman at the centre has a choice of any point of 180 miles (30 miles along any of the six radials). ... " (p. 120).

UP2 - 17

METROPOLITAN TRANSPORT PATTERNS

Metropolitan transport patterns can be divided into five types. The communications of the first two patterns terminate at the centre. This causes serious regional diseases. The last three patterns continue the relative accessibilities straight through, and terminate the communications in the outer parts of the metropolitan region. Our subdivision is due to Blum.[*]

Pattern 'A' shows a ring pattern which has the worst consequences of the lot. In several cases the radial lines of pattern 'A' have been extended and joined into a Central Railway Station, so going over into pattern 'B' and 'C'.

The integral accessibilities are then very different if we terminate all communications at the Centre as in pattern 'B', and very different if we continue the lines through the centre and terminate our communications on the fringes of the metropolitan region as in pattern 'C'.

Pattern 'D' opens up the single central focus of the metropolitan region, subcentralizing[**] the integral accessibility into a number of centres, and is therefore superior to pattern 'C', but it is still not the best, because the interchange between areas on line I and II, and areas on line III and IV, is difficult.

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[*] viz = O. Blum = Stadtebau, p.212 e.f., Berlin, Springer, 1937.

[**] To use the term of Mr. J. Faithfull, of the Cumberland County Council, N.S.W.

The three requirements: no overcentralization, clear diameter lines and easy transit between all parts of the metropolitan region are best fulfilled by Blum's pattern 'E'. This pattern is therefore recommended as a start (not as a recipe) for the development of a pattern for a metropolitan transport system. The framework of pattern 'E' can be also recommended in developing a network of trams or bus lines.

Much, of course, depends again on the ranges we are thinking in. If the distance between the centres of pattern 'D' or 'E' are insignificant if compared to the size of our Range, then patterns 'D' and 'E' go over into pattern 'C'. If we think in ranges in which the diameter of the ring, pattern 'A' is negligible, then pattern 'A' goes over into pattern 'B'.

PATTERN 'B'

Attempts have been made to correct the worst mistake of pattern 'A', i.e. the termination of the radial communications outside the City, with the resulting drop of integral accessibility of the core to insignificant values, by extending the radial communications according to pattern 'B' or 'C' into the core of the metropolis and joining them here into a "Central Railway Station".

In doing this, however, some transport departments appear unaware how different the results are if we terminate all lines of transport in the centre of the City, having them return outward over the same ground again, and how different the accessibilities are if we do not terminate our transport lines in the core of our metropolis, but continue them clearly through and terminate our communications on the other side of the City, in the outer parts of our metropolitan region.

For the case of all transport lines terminating in the centre the situation is summed up in the adjoining table, and graphically represented in figure UP2 - 18 .

This transport pattern creates an enormous peak of some 225 landmarks of integral accessibility at the centre, surrounded by a ring of low accessibility of some 9 landmarks in a radius of about two miles around the centre, and from here outwards the integral accessibility is rising again, to reach 15 landmarks about 30 miles outside.

Now this ring of low integral accessibility has a strong concentrating effect, because any business company who has a choice of placing its office building say at Wynyard Square, Sydney, (where all the buses terminate and where you can arrive directly), or in the inaccessible ring, say at Sydney University, where a man from Narrabeen has to make his way first to Wynyard Square, like the man of the former case, and then try to find some bus or tram that would take him out again from the centre, such business company will not analyze the transport pattern and the possibilities created by other patterns, but will, by commonsense, prefer the Centre. The City is surrounded by an invisible, strictly concentrating ring, if all the transport terminates at the centre.

In the case of an urban district centre, like Manly or Hurstwille (in Greater Sydney), this concentrating effect might be desirable if our aim is to concentrate sharply all private business there, but it is certainly undesirable in a single employment core of a metropolis of more than 800,000 inhabitants.

The essence of the situation can be understood if we observe that a businessman 30 miles outside such metropolis has the choice of travel without interruption to anywhere within 60 miles, (30 miles outward and 30 miles toward the centre). A man 2 miles near the centre has his choice limited

to 32 miles, (30 outward but only 2 miles inwards) and a businessman at the centre has a choice of any point of 180 miles (30 miles along any of the six radials, i.e. 180 miles).

So a business away from such metropolis can be approached by people from a certain area. A business near the centre has just about half this choice, while the choice of a business in the centre itself jumps suddenly to a multiple of the original value.

If all the transport facilities terminate in the centre, then some of the most inaccessible places of the metropolitan region are in the nearest vicinity of the core, immediately surrounding the centre. The highly accessible centre is surrounded by an inaccessible ring.

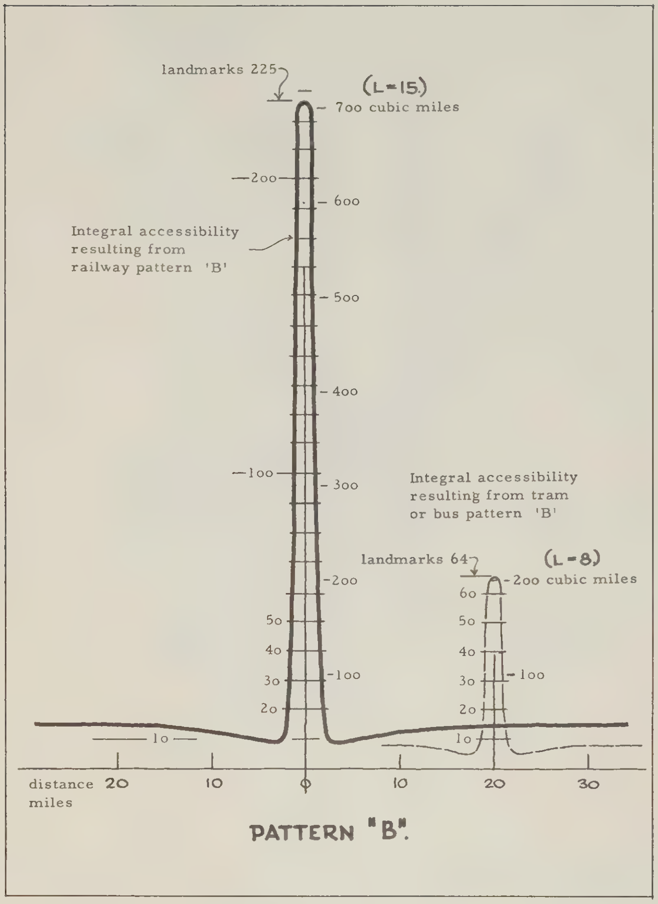


Fig. UP2 - 18

Our figure shows two peaks of integral accessibility, the left one generated by railways, the right one resulting from a bus pattern. The smaller peak, of 64 landmarks, is the result of focusing a number of bus lines according to pattern 'B' on one spot; (Manly or Hurstville in Greater Sydney, Australia are examples).

The left peak, the tall one, is the result of focusing the railways of a region in a similar manner.

If we focus our railways according to pattern 'B', then this pattern makes the centre 225 landmarks accessible and the places near the centre only 9 landmarks accessible. "This pattern creates an enormous peak of some 225 units of integral accessibility at the centre, surrounded by a ring of low accessibility of some 9 units about two to three miles around that centre."

These values are based on a one mile walking distance, or a corresponding 8 miles range of travel by bus, or a 15 miles range of travel by electric railways.

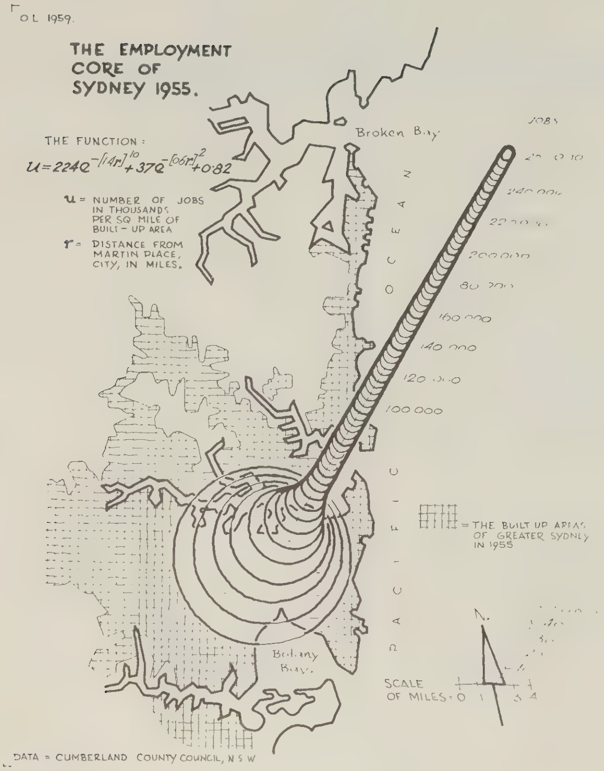

OL 1959.
THE EMPLOYMENT CORE OF SYDNEY 1955.
THE FUNCTION:
u=224e^-[1.4r]^10+37e^-[0.6r]^2+0.82
u = NUMBER OF JOBS IN THOUSANDS PER SQ MILE OF BUILT-UP AREA
r = DISTANCE FROM MARTIN PLACE, CITY, IN MILES.
Broken Bay
JOBS
240 000
220 000
200 000
180 000
160 000
140 000
120 000
100 000
PACIFIC OCEAN
= THE BUILT UP AREAS OF GREATER SYDNEY IN 1955
N.
Botany Bay
SCALE OF MILES: 0 1 3 4
DATA = CUMBERLAND COUNTY COUNCIL, N S W

Fig. UP2 - 19

To compare integral accessibility and employment, we have plotted here on the vertical scale the number of jobs per square mile of the built-up area of Greater Sydney, N. S. W., The illustration is from an employment study of the late Mr. F. Farago and of the author at the Cumberland County Council, Australia. To condense this analysis I graduated the figures. Now the report consists of four letters and seven numbers only.

The function:

$$u = 224\ e^{-(1.4\ r)^{10}} + 37\ e^{-(0.6\ r)^{2}} + 0.82\ ,$$

u = number of jobs in thousands,
r = distance in miles from centre,

gives a fairly correct picture of the distribution of employment throughout Greater Sydney in 1955. It gives a fairly accurate estimate of the number 'u' of jobs, established per square mile of the built-up area in any place of the County of Cumberland, N. S. W..

These values plotted above are therefore not accessibility, but employment figures. In our metropolises the relationship between integral accessibility and employment is certainly striking.

FIGURE A.3

DRAFT OFFICIAL PLAN 1970 OF THE CITY OF HAMILTON

METROPOLITAN TRANSPORT PATTERNS

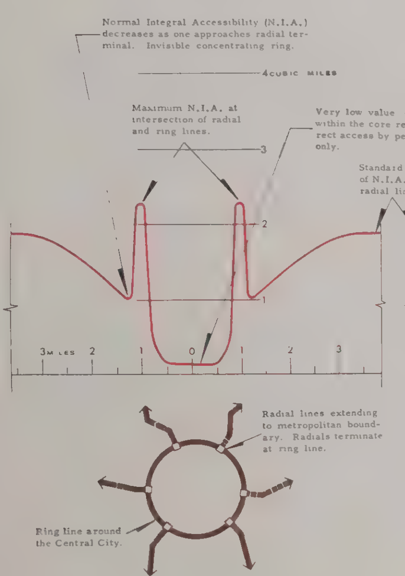
CONSTANTS

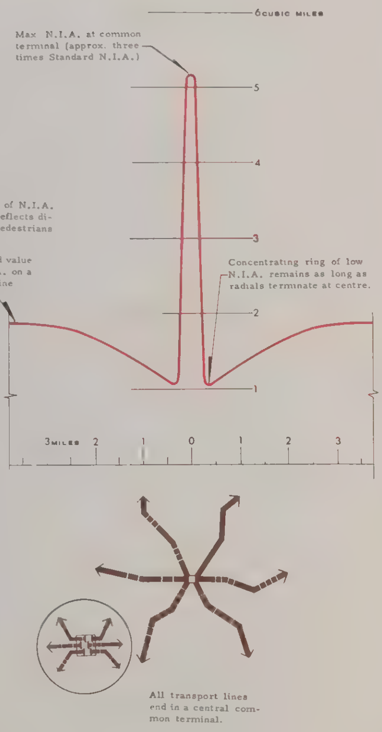
PEDESTRIAN RANGE: $r_0 = 0.2$ MILES
SHRINKAGE FACTOR: $L = 15$
TRANSIT RANGE: $R_0 = Lr_0 = 3.0$ MILES

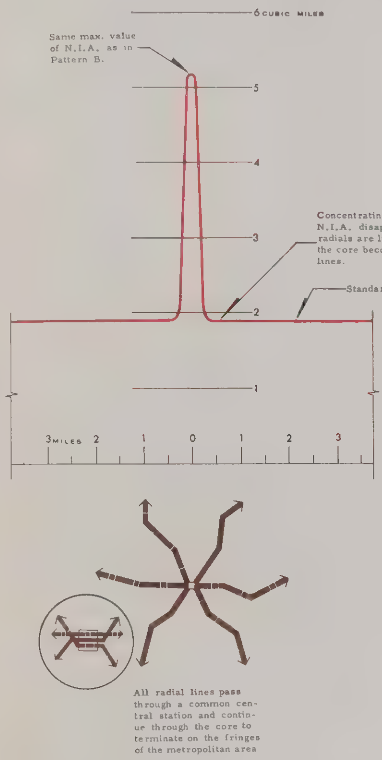
TRAVEL PARAMETERS

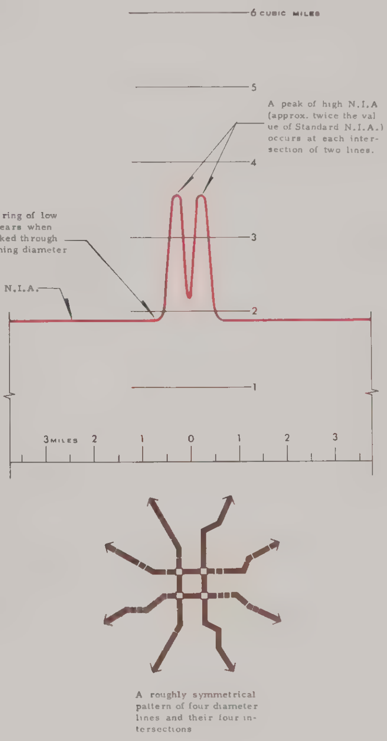
a = DISTANCE FROM ORIGIN TO REACH TRANSPORT LINE
b = DISTANCE TRAVELLED ALONG TRANSPORT LINE
c = DISTANCE FROM TRANSPORT LINE TO REACH DESTINATION

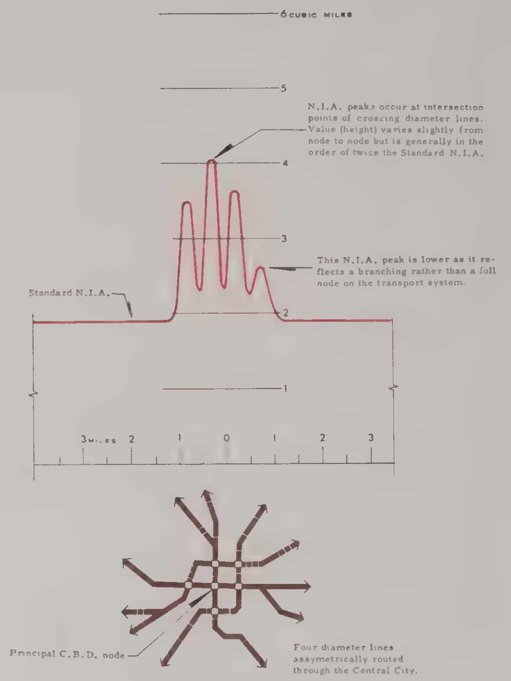
$$N.I.A. = \int \int \int \exp -\left[\left(\frac{a+c}{r_0}\right)^2 + \left(\frac{b}{Lr_0}\right)^2 \right] dx\,dy\,dz$$


Normal Integral Accessibility (N.I.A.) decreases as one approaches radial terminal. Invisible concentrating ring.
4 CUBIC MILES
Maximum N.I.A. at intersection of radial and ring lines.
Very low value of N.I.A. within the core reflects direct access by pedestrians only.
Standard value of N.I.A. on a radial line
3
2
1
3 MILES 2 1 0 1 2 3
Radial lines extending to metropolitan boundary. Radials terminate at ring line.
Ring line around the Central City.


6 CUBIC MILES
Max N.I.A. at common terminal (approx. three times Standard N.I.A.)
5
4
3
2
1
Concentrating ring of low N.I.A. remains as long as radials terminate at centre.
3 MILES 2 1 0 1 2 3
All transport lines end in a central common terminal.


6 CUBIC MILES
Same max. value of N.I.A. as in Pattern B.
5
4
3
2
1
Concentrating ring of low N.I.A. disappears when radials are linked through the core becoming diameter lines.
Standard N.I.A.
3 MILES 2 1 0 1 2 3
All radial lines pass through a common central station and continue through the core to terminate on the fringes of the metropolitan area


6 CUBIC MILES
5
A peak of high N.I.A (approx. twice the value of Standard N.I.A.) occurs at each intersection of two lines.
4
3
2
1
3 MILES 2 1 0 1 2 3
A roughly symmetrical pattern of four diameter lines and their four intersections


6 CUBIC MILES
5
N.I.A. peaks occur at intersection points of crossing diameter lines. Value (height) varies slightly from node to node but is generally in the order of twice the Standard N.I.A.
4
3
This N.I.A. peak is lower as it reflects a branching rather than a full node on the transport system.
Standard N.I.A.
2
1
3 MILES 2 1 0 1 2 3
Principal C.B.D. node
Four diameter lines assymetrically routed through the Central City.

PATTERN A

THE ACCESSIBILITIES WHICH RESULT FROM THE TERMINATION OF RADIAL COMMUNICATIONS OUTSIDE THE CITY CENTRE ARE VERY UNFORTUNATE. EXCEPT FOR THE SHARP PEAKS WHERE THE RADIALS CROSS THE RING LINE, OUTSIDE THE CENTRE, INTEGRAL ACCESSIBILITY ASSUMES A NEGATIVE GRADIENT AS WE APPROACH THE CORE. THE LOW ACCESSIBILITY OF THE CORE, IF MAINTAINED FOR SEVERAL GENERATIONS WOULD NATURALLY RESULT IN A DEAD HEART OF THE METROPOLIS.

PATTERN B

THIS TRANSPORTATION PATTERN CREATES AN ENORMOUS PEAK OF INTEGRAL ACCESSIBILITY AT THE CENTRE, SURROUNDED BY RING OF LOW ACCESSIBILITY. THIS INVISIBLE RING HAS A STRONG CONCENTRATING EFFECT, GIVING RISE TO SOME OF THE MOST INACCESSIBLE PLACES OF THE METROPOLITAN REGION IN THE NEAREST VICINITY OF THE CORE, IMMEDIATELY SURROUNDING THE CENTRE.

PATTERN C

BY CONTINUING THE RADIALS THROUGH THE CENTRE CLEAR TO THE OTHER SIDE OF THE METROPOLITAN AREA, RATHER THAN TERMINATING THEM AT THE CENTRE, THE CONCENTRATING RING OF LOW ACCESSIBILITY ABOUT THE CORE IS ELIMINATED. HOWEVER, THE MAINTENANCE OF A SINGLE COMMON POINT OF INTERSECTION WITHIN THE CORE CARRIES WITH IS THE UNDESIRABLE ELEMENT OF OVERCENTRALIZATION.

PATTERN D

THIS WELL KNOWN PATTERN OPENS UP THE SINGLE CENTRAL FOCUS, SUBCENTRALIZING ITS INTEGRAL ACCESSIBILITY INTO A NUMBER OF CENTRES, AND IS THEREFORE SUPERIOR TO PATTERN "C". HOWEVER, IT IS STILL NOT QUITE CORRECT, BECAUSE THE INTERCHANGE BETWEEN AREAS ON LINES I AND II, OR AREAS ON LINES III AND IV, IS CUMBERSOME, REQUIRING TWO LINE TRANSFER OPERATIONS. THUS, THE PROBLEM IS ONE OF RELATIVE ACCESSIBILITY.

PATTERN E

THE FLAW OF PATTERN "D" IS OVERCOME BY AN ARRANGEMENT WHEREIN EACH LINE INTERSECTS EVERY OTHER LINE AT, AT LEAST, ONE POINT. SUBCENTRALIZATION OF INTEGRAL ACCESSIBILITY IS ACHIEVED TO AN EQUAL OR BETTER DEGREE, DUE TO THE INCREASE IN THE NUMBER OF INTERSECTION FOCI. NO MORE THAN ONE INTERCHANGE IS REQUIRED TO TRAVEL BETWEEN ANY TWO POINTS ON THE SYSTEM.

CITY OF HAMILTON PLANNING DEPARTMENT
March 1969 First Edition

ACCESSIBILITY AND EMPLOYMENT

"Cities", I am sometimes told, "just grow". Too true; and how they grow, along the man-made patterns of accessibility, and into other patterns of accessibility beyond control of man, requires a few words in this Chapter.

The Report of the Town Planning Institute (London 1956) on planning in the London Region:-

"67. Employment in the London Region is expanding more rapidly than the total population, and also more rapidly than employment in the rest of the country. Between June 1948 and May 1952, employment in the Region increased by some 215,000 an expansion of 4.5 per cent - compared with a population growth of only 1.9 per cent in the same period. Furthermore, this rate of increase was considerably higher than that of Great Britain as a whole, which was 2.6 per cent. The ratio of employees to resident population, which was already higher in London than in the rest of the country, has in consequence continued to rise.

74. There is no evidence of any significant shift in employment from the inner to the outer parts of the London Region.

75. All the increase in employment in Greater London is taking place at the centre."

So far the report of the Town Planning Institute, London.

It is not always realized that places of employment are the most movable objects of human society - so long as they are not located in the most accessible places. It is often not clearly understood that jobs not established in locations of highest integral accessibility (or as close as possible to them) have the tendency to move at a slighest violation of their unstable equilibrium into the above-mentioned locations. In fact, such employment moves so easily, that, since the last eighty years or so, since man created by mechanized transport places of

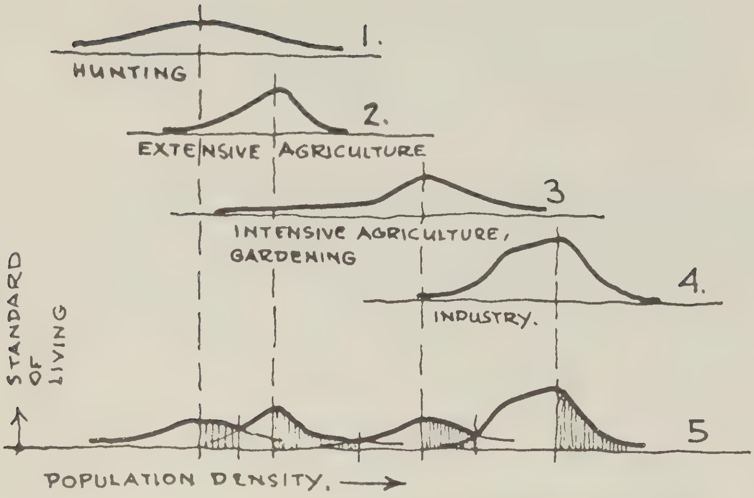
extremely high (integral) accessibility and left some places without mechanized transport as little accessible as they were before, there came into being, and continues, an almost uninterrupted flow of jobs into places of highest integral accessibility.

For Robinson Crusoe, this flow of employment might be of academic interest only. He owns his island, and cannot leave his inaccessibility. For the rest of our interconnected humanity, in which more than 90% depend for survival on a job, the situation is, in about 120 places of our globe, as follows:- The huge integral accessibility of the centre of London on regional level, the immense integral accessibility of that centre in national dimensions and the enormous integral accessibility of the same position on a global scale concentrates jobs from the region, the nation and the globe into the centre of London (viz. figs. UP2.10 and UP2.11) and the population then has to live within a certain relative accessibility from this centre, say, within daily access.

Where the integral accessibility is low, there apply Griffith Taylor's three main factors governing the distribution of mankind:- "King Cold, King Drought and King Coal".

Also, Wagemann's "Alternating law of population densities" retains its value over the greatest part of our globe. But in the above 120 places or so, where man has created, or is creating, by mechanized transport, places of extremely high integral accessibility, a different, fourth factor appears to be having an upper hand, and here we might expect some help from the concepts of integral and relative accessibility.

It is not suggested that we have to desire a huge technological agglomeration in which all humanity of man is lost, although we do not know all the good, bad and indifferent, results and all their combinations; "Almighty has His own purposes". It is not suggested that this trend is good, but there is no chance to cure anything deliberately, unless its causes are clearly understood. If the monstrous height of the man-made integral accessibility in the places where our metropolises spring up, is one of the chief causes of their growth into monstrous sizes, then a clear cut concept of integral accessibility is a prerequisite fundamental for a handling of this question with success.



UP2 - 20

The above attempts to illustrate what Wageman called the law of alternating densities. The standard of living is plotted against population density of a country. A country like Patagonia will have a maximum per capita income at a certain density (graph 2.). Experience shows, that the maximum of an industrialized country, such as Switzerland is reached at a different, higher density (graph 4.).

Upon a superimposition of the graphs (graph 5.), we see, that there is no reason save an accident, why two neighbouring peaks should have no saddle between. Hence difficulties of overpopulation will be experienced in a transitory stage, on the right hand sides (shaded) of the above graphs. In this sense then an absolute overpopulation of a country does not exist. An area is underpopulated, if its prosperity is increasing with a population increase.

DISTRIBUTION OF POPULATIONS IN HISTORY

The attractive powers of places of high integral accessibility are, however, only partly economic in their nature. Human will, preferences, prejudices or desires are an important element. "opinion can do much, and, in fact, she is that great Lady that rules the world". So some say that the greater part of the call of the place of high integral accessibility is psychological. There is a certain desire perceptible in human kind to live its life in well-known places in preference to life in anonymous, unknown areas.

Just compare how many inhabitants of Jamaica might think of going to London, and how many of them think of going to Lhassa in Tibet, or to an even less known place such as old Adaminaby, New South Wales.

Then, for instance, think about the number of people in Malaya into whose minds the idea of going to London might enter, and how many of them would think of going to Lhassa or Adaminaby.

Then repeat the procedure for another say million at random selected points on our globe, compare the results for Lhassa with the results for London, and the effect of the great integral accessibility of London on a global scale will be evident.

As highly accessible places get, generally speaking, a greater share of publicity in the life of a modern state, as well accessible places get more frequently mentioned in the tales of ancient tribes, as places of higher integral accessibility become generally better known to mankind at large, a gradient must develop, a tension must arise, a psychological power starts operating upon the human mind, producing a

desire of people and a resulting movement from places of lower integral accessibility to places of higher integral accessibility. In historical perspective this seems no trifle.

Throughout history, since the times when man learned to navigate the seas, there is a movement of populations perceptible, from the interior of continents towards the shores of the oceans. And, incidentally, since man became seafaring, the coastal areas of our globe became the places of highest integral accessibility. Did the coastal areas acquire with this high accessibility just this little touch of higher "call" which formed the gradient to set the desires of tribes into motion towards the coast?

Is the reason for the eastward-coastward movement of populations in East Asia, or the westward-coastward movement of people in Europe: Turks, Tartars, Hungarians, Germans, Greeks and others before them accidental? Or can these movements be explained by global differences in integral accessibility?

In contrast to the last chapter, it is not suggested that this trend is bad. The areas of the seacoast are aesthetically so much superior that it is basically desirable to have as many people as possible living in contact with this beautiful environment. Think of the surroundings of Sydney with the radiant Warringah peninsula, the areas of Illawarra, the blue water views of Port Jackson and Broken Bay, or think of Puget Sound in Canada, or of the dramatic verticals reflected in the Bay of Rio de Janeiro. Indeed, the areas wherefrom the eye can behold sea and land simultaneously in the same view are amongst God's most beautiful creations on this Earth and we do therefore suggest that this tendency of man, or at least of the modern seafaring nations towards the coast, is good. But we do not deceive ourselves about the nature of the powers that will finally decide the issue. There are economic and psychological powers very closely related to the concept of integral and relative accessibility operating on the life and distribution of mankind.

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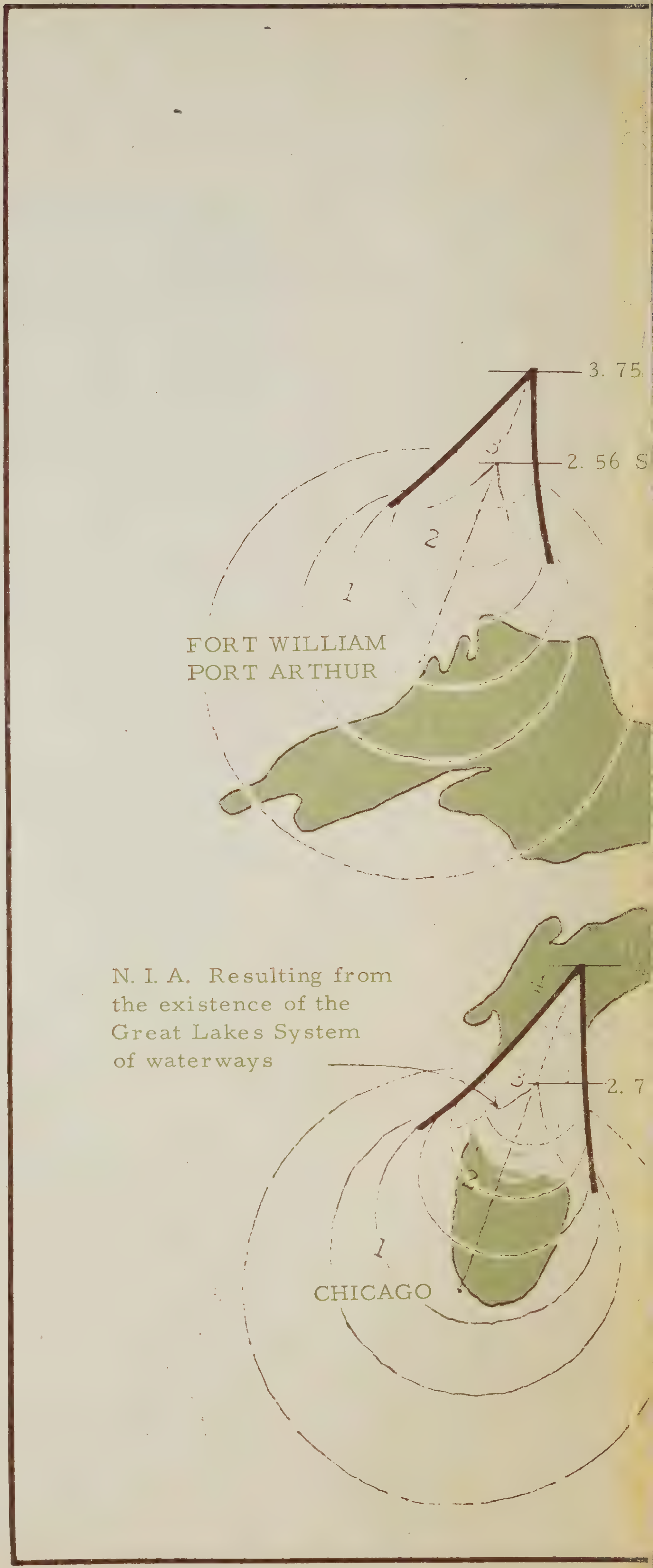
11552

OUR GLOBE is now laced with transport routes. The areas of our world have become very accessible from each other, with great consequences to mankind. The intimate relationship is remarkable, of high integral accessibility, and of places where concentrations of employment grow.

The illustration on this cover portrays the integral accessibilities resulting solely from shipping, and shows changes caused by the opening of the St. Lawrence Seaway. The accessibility by shipping, of Toronto for example, has increased from 2.61 units to 7.05 units of integral accessibility.

By definition integral accessibility is an abstract concept only, yet it is already a powerful tool of the planner, and we do not deceive ourselves about the nature of the powers that will finally decide the issue. There are economic and psychological powers very closely related to the concepts of integral and relative accessibility operating on the LIFE AND DISTRIBUTION OF MANKIND,


3. 75
3
2. 56 S
2
1
FORT WILLIAM
PORT ARTHUR
N. I. A. Resulting from the existence of the Great Lakes System of waterways
3
2. 7
2
1
CHICAGO